ST. LUCIE COUNTY SOUTH BEACH AND DUNE RESTORATION PROJECT

DRAFT ENVIRONMENTAL IMPACT STATEMENT

MAY 2011

SUMMARY

DRAFT ENVIRONMENTAL IMPACT STATEMENT ON ST. LUCIE COUNTY SOUTH BEACH AND DUNE RESTORATION PROJECT ST. LUCIE COUNTY, FLORIDA

Need or Opportunity. St. Lucie County is located on Florida's east coast about 100 miles north of Miami and due east of Lake Okeechobee. The county's coastline consists primarily of 21.5 miles of South Hutchinson and North Hutchinson Island, elongated barrier islands generally a mile or less wide separated by Ft. Pierce Inlet. The Indian River Lagoon, Ft. Pierce Inlet, and St. Lucie Inlet separate South Hutchinson Island from Florida's mainland. The project area lies within the southernmost 5.2 miles of the St. Lucie County shoreline.

The coastline and barrier islands of St. Lucie County are low-lying and vulnerable to storm surge and other storm event damages. Problems along the project area include sand erosion and lowering of the beach profile with subsequent recession of the shoreline and dunes. The purpose of the proposed project is to restore recreational beach, restore beach and dune habitat, and reduce storm damage due to beach erosion along the ocean shoreline of St. Lucie County. Hurricanes and severe "northeasters" have caused considerable erosion and damage to shoreline structures within the project area. Along parts of the shoreline, beach and dune erosion has made seawalls, buildings, and other structures vulnerable to severe storm damage.

The St. Lucie County Erosion District (the Applicant) has proposed the St. Lucie County South Beach and Dune Restoration Project design (the Applicant's preferred plan) as a plan to provide storm damage protection to structures threatened by chronic shoreline retreat and storm-induced beach erosion. The project also maintains an area suitable for recreation and wildlife habitat.

The US Army Corps of Engineers (USACE) determined that the proposed project required an Environmental Impact Statement (EIS) as part of the U.S. Department of the Army (DOA) Dredge and Fill Permit application process. St. Lucie County has also submitted a Joint Coastal Permit (JCP) application for this project to the State of Florida Department of Environmental Protection (FDEP). The Department of the Army (DA) authorization (if approved) would provide St. Lucie County with the necessary federal authorization to proceed with the project.

The USACE is also performing a feasibility study considering a federal project on the same shoreline extent. This Regulatory Division Environmental Impact Statement (EIS) prepared by the USACE for the county project may provide part of the appropriate National Environmental Policy Act (NEPA) review for a future USACE Planning Division federal beach stabilization project at this project site. The USACE is currently conducting the St Lucie County Florida Hurricane and Storm Damage Reduction Study Feasibility Report to assess the site for a federal project.

County objectives (benefits) include (1) re-establishing beaches as suitable recreational areas to maintain commerce associated with beach recreation in St. Lucie County; (2) maintaining suitable beach habitat for nesting sea turtles, invertebrate species, and shorebirds; and (3) reducing expected storm erosion damages to property and infrastructure.

Major Findings and Conclusions. This DEIS will determine if St. Lucie County can construct the proposed project without producing unacceptable environmental impacts.

This DEIS considers possible adverse impacts to the beach, nearshore hardbottom resources, and offshore sand borrow area resources and adjacent habitat. Significant issues addressed include potential direct short-term (construction related), indirect, and cumulative effects on protected species, water quality, essential fish habitat (EFH), fish and wildlife resources, benthic communities, sediment transport, wave modification, cultural and socioeconomic resources, and aesthetics and recreation.

St. Lucie County has proposed measures to avoid and minimize impacts, and to mitigate for unavoidable impacts associated with obtaining offshore beach fill material and nourishing the project beach. Based on UMAM calculations prepared by the Applicant and reviewed for this DEIS, mitigation for impacts of the Applicant's preferred plan to nearshore hardbottom will require that the Applicant construct 0.98 acres of nearshore artificial reef at one or more sites located along the project shoreline. Other alternatives considered in detail have greater or lesser impacts and related mitigation. St. Lucie County has identified likely locations for artificial reef placement in the general project area approximately 15 feet (ft) of water and up to about 1,000 ft offshore. The Applicant and FDEP are continuing to resolve a final level of impact and the level of mitigation required to offset all impacts identified by the state. The USACE will consider those findings when they become available.

A proposed biological monitoring plan would assess success of the mitigation reef and direct, secondary, and long-term effects to nearshore hardbottom habitat associated with the proposed project. A sedimentation and turbidity monitoring plan has been proposed to assess, avoid, and/or minimize impacts to reef communities adjacent to the proposed borrow areas during project construction.

Final comments from the public, the National Oceanographic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS), FDEP, and the Florida Fish and Wildlife Conservation Commission (FWC) regarding the DEIS will be addressed and resolved prior to completion of the EIS. If recommended for approval, the USACE Dredge and Fill Individual Permit and the FDEP Joint Coastal Permit (both now under review by the federal and state agencies and their commenting agency partners) will provide general and specific conditions that St. Lucie County will follow to help minimize and avoid environmental impacts.

Alternatives. This DEIS evaluated a range of nonstructural and structural measures to reduce beach, land, and property losses resulting from erosion, storms, and hurricanes along Hutchinson Island. The evaluations considered the potential for each alternative to meet the county's project objectives and to maintain consistency with project constraints. A preliminary evaluation of each alternative determined whether an alternative would undergo further consideration and detailed evaluation.

The screening process used the St. Lucie County planning objectives to address the erosion problem by identifying and selecting the best course of action. The preliminary screening process eliminated those alternatives that did not resolve the needs of the problem area or meet the St. Lucie County planning objectives. Nonstructural alternatives did not meet the standards for detailed evaluation due to a combination of economic viability, effectiveness, and/or political or social acceptance. In particular, many of the nonstructural alternatives would minimize environmental impacts and would help to alleviate economic impacts on project area property owners, but would not meet study objectives because the beaches in the project area would continue to erode and result in a loss of recreational benefits and marine turtle nesting habitat. Other nonstructural alternatives would require homeowners to adopt actions that would likely prove infeasible or unacceptable or would require changes in law unlikely to obtain public acceptance. Various methods of hardened shore protection, such as revetments and seawalls, did not warrant further consideration because such measures would not function well in the study area, would not solve the erosion problem, and would not provide enhanced recreational and sea turtle nesting benefits. Structures (e.g. pep reefs, groins and breakwaters) might impede the erosion of sand did not meet project objectives.

This DEIS considered the following alternatives in detail:

1. No-Action Alternative (Status Quo)
2. Beach Fill with No Impact to Existing Hardbottom
3. Beach Fill to Restore the 1972 Beach and Dune
4. Beach Fill to Restore the 1972 Dune with a 35-ft Berm
5. Beach Fill to Restore the 1972 Dune with a 70-ft Berm
6. South Segment Beach and Dune Restoration; North Segment Dune Restoration Only
7. Beach and Dune Restoration with T-head Groins

The Applicant described differences in design and resulting differences in levels of protection to development and in levels of prevention of land loss. The alternatives provided different recreational benefits and varying environmental impacts. Alternative 6 (South Segment Beach and Dune Restoration; North Segment Dune Restoration Only) was shown to greatly decrease impacts to hardbottom habitat but also reduce storm protection in the project north segment. However, modeling also showed that over time, dispersion of south segment beach fill increased the width of the north segment beach when the north beach had not received fill. Comparing performance of the Applicant's preferred plan (Alternative 4) and the "North Segment Dune Restoration Only" (Alternative 6), after 10 years showed that the north segment beach widths were very similar, whether or not the north beach had been filled. Beach and dune fill with T-Head groins met county objectives but at a much greater cost with greater impacts.

Quality and quantity of sand used to nourish or replenish the eroding shoreline provide key components of beach nourishment project performance (NOAA 2008b). During project planning, the county considered locating an affordable and high quality sand source among the most critical plan aspects. Project alternatives considered three possible sand sources: offshore borrow areas located within the St. Lucie Shoal in state waters, offshore sand sources located in federal waters, and upland sand sources. Based on the availability of high quality sand within state waters and the extended level of effort necessary to obtain leases to dredge in federal waters, the county elected to propose the use of the borrow area in state waters. The county also proposed the potential use of borrow locations in federal waters as a source of sand for renourishments over the 50-year project life.

The upland sand source alternative did not receive detailed evaluation for this proposed project. The potential impacts to the public and public infrastructure resulting from overland delivery of sand for a project of the proposed magnitude (610,000 cy), coupled with the potential for the project to extend beyond the proposed one-season schedule, and the greatly increased project cost for production and delivery of acceptable quality upland sand provided sufficient reason to eliminate the alternative from detailed consideration.

Applicant's Preferred Alternative. The Applicant's preferred alternative, Beach Fill to Restore the 1972 Dune with a 35-ft Berm from an offshore sand source, addresses the local planning objectives, anticipates beach erosion losses, and considers the needs of the study area. This measure includes initial construction of a beach fill area of appropriate dimensions to serve as a buffer against wave attack.

St. Lucie County proposes construction of a protective and recreational beach along about 3.8 miles of shorefront including two beach sections: 1) southward from Florida Department of Environmental Protection (FDEP) R monument (R)-87.7 to R-90.3 and 2) R-98 to the St. Lucie/Martin County line (R-115+1,000 ft). The first section, R-87.7 to R-90.3, is located north of a beach segment designated as a Coastal Barrier Resource System (CBRS Unit P-14) beach. The county eliminated this CBRS beach (R-90.3 to R-98) because the FDEP had not identified that beach segment as "critically eroded". The second section of project beach is located between R-98 (the end of the CBRS beach segment) and R-115+1,000 ft. The south project section includes a section of CBRS Unit P-14 from R-101.1 to R-101.3. The county included this CBRS beach segment because the FDEP has defined it as critically eroded.

The Applicant's preferred alternative design consists of dune restoration with an added crest width of between about 9 ft and 67 ft (average about 38 ft) at a crest elevation of 12.5 ft NAVD88. The landward slope on the restored dune face lies at 3H: 1V (where applicable); the same slope on the seaward face of the restored dune face extends seaward to elevation 5.35 ft NAVD (the restored dune toe). From the toe of the restored dune, the beach berm extends seaward 35 ft at a 100H:1V top slope with a 10H:1V slope on the seaward face to the existing grade. A seaward extension of about 25 ft of the beach berm, at a 100H:1V top slope and 10H:1V seaward face slope, provides "advance" fill to offset expected future erosion. Planting of salt-tolerant native dune vegetation on the restored dune crest to help stabilize the dune completes the design. In addition, extension of existing public beach access dune walkovers provides access to the restored beach.

Approximately 610,000 cy of fill with an average fill density of 30.5 cy/ft would be necessary to complete the applicant's preferred project. St. Lucie County has identified an area at the southeast end of St. Lucie Shoal, approximately three miles offshore in state waters, as the proposed borrow area. Seismic and core boring investigations indicate that this area contains quantities (about 1.3 million cy) of beach quality material. Projected (future) renourishment events would require 200,000 cy of fill at approximately 10-year intervals. The borrow area currently identified for project use and additional areas further along St. Lucie Shoal in federal waters could provide sufficient sand for a 50-year project life.

Construction would occur between November 1 and May 1 to avoid impacts to nesting of marine turtles. Impacts of the project would include 1.08 acres of hardbottom habitat. To mitigate for those impacts, St. Lucie County has proposed creation of mitigation reefs comprised of limestone boulders placed in areas of suitable, relatively shallow (12 – 15 ft deep) nearshore waters within the project area. Suitable mitigation sites include areas with sand about 1.0- to 4.0-ft deep overlying hard substrate.

The Applicant's preferred plan maximizes county-estimated net economic benefits and meets the county objectives of restoring a beach for storm protection and for recreational and environmental needs of the project area. Beach restoration using dredged material from the proposed offshore borrow areas would most cost-effectively accomplish all the project objectives with less adverse impact on the coastal system. Therefore, this measure carries forward as the proposed alternative.

Issues Raised by the Public and Agencies. As requested by the USACE on 21 April 2010, the Federal Register published a Notice of Intent (NOI) to prepare the Draft EIS for the St. Lucie County South Beach and Dune Restoration Project located in St. Lucie County, Florida. Taylor Engineering, Inc., a contractor to the USACE for the EIS, mailed the NOI to interested and affected parties by letter dated 30 April 2010. The USACE and Taylor Engineering coordinated with the public and relevant federal, state, and local agencies. Summaries of issues of concern raised by respondents to the NOI and EIS scoping meetings held in May and June 2010 begin below. The scoping period ended 20 June 2010.

Comments from the public included suggestions that the EIS consider using artificial reefs or other structural alternatives for shore protection, consider using upland sources for beach material, and consider using local labor for the project. Others expressed concern about the use of St. Lucie Shoal as a borrow area given potential adverse effects on the shoreline and sand compatibility issues. Others who supported the project were concerned that ignoring erosion could lead to county-wide impacts. Public participants expressed concern for marine life, including marine turtles, fish, and worm reef populations. Finally, some suggested that the EIS consider more cost-effective and permanent solutions to beach erosion.

The NOAA Fisheries Service (NOAA-FS) representatives indicated that their concerns for the proposed project were similar to those they had described to Martin County and others proposing similar beach fill projects using offshore sand sources. Those concerns included the potential significant adverse impacts of excavation of offshore shoals on the wave climate on the adjacent beaches. They indicated that shoal excavation had the potential to impact living marine resources, in particular the relatively poorly understood fish communities and the uses those species likely make of the shoals. They asked questions about dredging construction methods and the uses of the shoals by various groups of animals. They suggested potential approaches to evaluating the hardbottom and hardbottom impacts and expressed concern that offshore borrow area excavations and placement of fill below mean high water could adversely affect hardbottom habitat, including corals and worm reefs colonized by *Phragmatopoma lapidosa.* They requested that the USACE continue to coordinate closely with them. They suggested that the USACE also review NOAA-FS letters evaluating other proposed projects.

Meetings with representatives from state agencies provided suggestions to consider carefully beach fill on the project northern segment, as some participants believed that sand placed in that location would erode very rapidly and provide little storm protection benefit. In that case, nourishment of the northern section might prove difficult to justify, as a significant fraction of the hardbottom impacts occur in that area. Other participants suggested that more hardbottom than the Applicant mapped actually occurred in the project area and that the loss of nearshore hardbottom habitat would constitute a significant concern. Participants suggested that monitoring efforts include the project mixing zones and consider the impacts of adjacent projects on the proposed project area. FWC suggested that from a nesting sea turtle perspective, beach design should include a more gradual slope.

Areas of Controversy. Interested agencies and other parties will likely raise controversial issues during review of the Draft EIS and the related public comment meeting. The Final EIS will fully address these issues.

Unresolved Issues. The proposed project includes new construction, both in borrow and fill areas of the project. The project design, the level of hardbottom impact created by project construction, the level (but not kind) of mitigation, use of the proposed offshore borrow area, and the impacts that offshore shoal dredging would create constitute the main unresolved issues for the proposed St. Lucie County South Beach and Dune Restoration Project. The project provides very similar impacts to the impacts associated with the adjacent Martin County Shore Protection Project. The predicted level of impacts and mitigation opportunities are relatively well understood, except for the effects of shoal dredging on offshore fish communities. St. Lucie County has committed to avoiding and minimizing impacts where possible, and mitigating for unavoidable adverse effects created by project construction. The permit application indicated that biological, sedimentation, and turbidity monitoring during all phases of project construction would protect resources within and adjacent to the fill and borrow areas. All these issues and solutions offered in the permit application are under consideration as part of this EIS process

DRAFT ENVIRONMENTAL IMPACT STATEMENT ON ST. LUCIE COUNTY SOUTH BEACH AND DUNE RESTORATION PROJECT ST. LUCIE COUNTY, FLORIDA

TABLE OF CONTENTS

APPENDICES

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

ADA	American with Disabilities Act
BOEMRE	Bureau of Ocean Energy Management, Regulation, and Enforcement
CBRA	Coastal Barrier Resources Act of 1982
CBRS	Coastal Barrier Resources System
CCSP	U.S. Climate Change Science Program
CETAP	Cetacean and Turtle Assessment Program
CFR	Code of Federal Regulations
Coastal Tech	Coastal Technology Corporation
CPE	Coastal Planning and Engineering, Inc.
CSA	CSA International, Inc.
CWA	Clean Water Act
cy	cubic yards
DEIS	Draft Environmental Impact Statement
DNRBS	Department of Natural Resources Beaches and Shores
DOA	U.S. Department of the Army
E.O.	Executive Order
EAI	Ecological Associates, Inc.
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
ESA	Endangered Species Act of 1973
ETOF	Equilibrium Toe of Fill
F.A.C.	Florida Administrative Code
F.S.	Florida Statutes
FCMP	Florida Coastal Management Program
FDEP	Florida Department of Environmental Protection
FL	Florida
FMC	Fisheries Management Council
FMP	Fisheries Management Plan
FNAI	Florida Natural Areas Inventory
FPL	Florida Power and Light, Inc.
ft	foot or feet
FWC	Florida Fish and Wildlife Conservation Commission
FWRI	Fish and Wildlife Research Institute
GPS	Global Positioning System
HAPC	Habitat Area of Particular Concern
hp	horsepower
hr	hour
ICW	Intracoastal Waterway
INBS	Index Nesting Beach Survey
IPCC	Intergovernmental Panel on Climate Change
IPF	Impact Producing Factor

LIST OF ABBREVIATIONS (Cont.)

JCP	Joint Coastal Permit
kg	kilogram
m	meter
MBTA	Migratory Bird Treaty Act of 1918
Mcy	Million Cubic Yards
MHW	Mean High Water
MHWL	Mean High Water Line
mm	millimeters
MMPA	Marine Mammal Protection Act of 1972
MMS	Minerals Management Service
MSL	Mean Sea Level
NAVD	North American Vertical Datum 1988
NEPA	National Environmental Policy Act of 1969
NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Administration
NOI	Notice of Intent
NTU	Nephelometric Turbidity Units
OCS	Outer Continental Shelf
PEP	Prefabricated Erosion Prevention
RBA	Regional Biological Assessement
RHA	Rivers and Harbors Act of 1899
SADRBO	South Atlantic Division Regional Biological Opinion
SAFMC	South Atlantic Fisheries Management Council
SHPO	State Historic Preservation Office(r)
SNBS	Statewide Nesting Beach Survey
U.S.C	United States Code
UMAM	Uniform Mitigation Assessment Methodology
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
VOC	Volatile Organic Compounds
WIS	Wave Information Study

DRAFT ENVIRONMENTAL IMPACT STATEMENT ON ST. LUCIE COUNTY SOUTH BEACH AND DUNE RESTORATION PROJECT ST. LUCIE COUNTY, FLORIDA

1. PROJECT PURPOSE AND NEED

1.1. PROJECT PURPOSE

The U.S. Army Corps of Engineers (USACE) has prepared this Draft Environmental Impact Statement (DEIS) in accordance with the National Environmental Policy Act (NEPA) of 1969, as amended, to address environmental concerns associated with a proposed beach nourishment project in St. Lucie County, Florida. The St. Lucie County Erosion District, the federal (and state) permit Applicant (the local sponsor) for the proposed project, expects funding for the project from a combination of locally generated revenue sources, including possible county and state funds. No federal funds are involved with the proposed project.

This locally sponsored project involves federal action because the fill activities associated with beach nourishment require authorization through a U.S. Department of the Army permit under Section 404 of the Clean Water Act (CWA) (33 U.S.C. 1251 et seq.) and Section 10 of the Rivers and Harbors Act (RHA). The Jacksonville District USACE determined that the scope of the St. Lucie County South Beach and Dune Restoration project and cumulative impacts of beach nourishment could significantly affect the quality of the human environment, and that the CWA Section 404 and RHA Section 10 permits would collectively constitute a major federal action. Based on these determinations, an environmental impact statement is required pursuant to (1) Section 102(2)(c) of the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.), (2) the Council on Environmental Quality guidelines on preparing environmental impact statements (EISs) (40 CFR 1502.4 et seq.), (3) USACE Engineering Regulation 200-2-2, "Environmental Quality: Policy and Procedures for Implementing NEPA," and (4) Section 404 of the CWA of 1972 on permitting disposal sites for dredged or fill material (33 U.S.C. 1344), as amended.

For this Environmental Impact Statement (EIS), the USACE serves as the lead federal agency for Endangered Species Act (ESA) Section 7 and the Essential Fish Habitat (EFH) consultations. Under the Outer Continental Shelf (OCS) Lands Act, the Bureau of Ocean Energy Management, Regulation, and Enforcement (BOEMRE) has jurisdiction over mineral resources on the OCS. As a federal agency, BOEMRE is also subject to the requirements of the ESA and Magnuson-Stevens Fishery and Conservation Management Act. While the currently proposed project considers activity only in state waters, the permit application also indicates that in future projects, St. Lucie County plans to mine locations under BOEMRE jurisdiction. In addition, the USACE is currently developing a Feasibility Study for a federal project on part or all of the proposed project area. The federal project will use OCS sand borrow sources. This EIS may become part of the USACE's Feasibility Study documentation.

1.2. PROJECT NEED

The proposed beach nourishment project would restore a protective beach lost to historical and ongoing erosion. St. Lucie County beaches south of Fort Pierce Inlet have sustained long-term erosion due to the downdrift effects of the inlet, which has intercepted sand and deprived sand from the beaches south of the inlet. In addition, damaging storms have exacerbated the inlet's effects and caused significant sand losses along county beaches since at least 1972. Net erosion rates of 13.1 feet per year (ft/yr) (Coastal Tech 2009: Attachment P Conditions Assessment Report), long-term erosion, hurricanes, and emergency fill efforts have left numerous buildings with minimal dune protection (**Figure 1.2-1**).

Figure 1.2-1. Post-hurricane storm damage and escarpments, south Hutchinson Island, St. Lucie County, Florida. Top: from FDEP (2004). Bottom: (personal communication Lois Edwards, Coastal Tech; March 2011)

The Florida Department of Environmental Protection (FDEP) has classified much of the south St. Lucie County Atlantic shoreline as “critically eroded areas” where erosion threatens development interests (FDEP 2010). A network of FDEP survey monuments identifies coastal locations, including the project area shoreline, along St. Lucie County beaches. These monuments extend from R-01 at the northern county line to R-115+ 1,000 ft at the St. Lucie/Martin County line. The project includes the beach between R-87.7 to R-90.3 and R-98 to R-115+1,000 ft (the St. Lucie County/Martin County line). The proposed project does not include the beach between R-90.3 and R-98, part of the Coastal Barrier Resources System (CBRS) not defined as critically eroded. The federal government has also recognized portions of St. Lucie County as severely eroded. Congressional Resolution Dockets 2757 (July 23, 1998) and 2634 (April 11, 2000) authorized the USACE to study St. Lucie County beaches. The USACE completed the authorized reconnaissance level report in November 2002. The USACE completed a Section 905(b) for the St. Lucie County beaches from FDEP reference monument R-77 to the St. Lucie/Martin County line.

Hurricanes Frances and Jeanne made landfall on the Hutchinson Island, Florida project area September 5 and September 26, 2004, and severely eroded the beach (FDEP 2004). The Federal Emergency Management Agency authorized emergency dune restoration at roughly 10 cubic yards per foot (cy/ft) for the beach from R-98.4 to R-101.5, and from R-103.3 to the St. Lucie/Martin County line (PBS&J 2005). St. Lucie County undertook an emergency dune restoration project between R-88.3 and R-90.3 with state emergency funds (FDEP Project Agreement 07-SL2) providing dune construction at an average fill density of about 6 cy/ft and dune plantings. These emergency fill projects also added about 10 cy/ft of beach to most of the project area but did not restore the beach width, which accounts for much of the protection provided by beach-dune systems against storm damage.

The Jacksonville District USACE initiated a Feasibility Study on June 29, 2004 for the south St. Lucie County beaches. The ongoing feasibility study extends from R-77 to R-115+1,000 ft (the St. Lucie/Martin County line). After the USACE expended the initial Feasibility Study funding, completion of the federal feasibility study awaited necessary additional Congressional appropriation, received in 2009. The Feasibility Study requires an EIS.

Additionally, the USACE identified an alternative borrow site that contains sufficient beach quality sand. The borrow site lies within offshore shoals located in federal waters. BOEMRE (formerly Mineral Management Service) manages mineral resources in this shoal. As such, the USACE has solicited BOEMRE to serve as a cooperating agency on this EIS. As appropriate, the Feasibility Study will build on this EIS to complete the necessary NEPA documentation for a potential federal project.

Construction of any federal project would occur only after completion of both a Feasibility Study and any subsequent period for receipt of necessary federal appropriations. In a recent fiscal year (FY2006), Congress appropriated only ~$105 million for federally sponsored beach nourishment projects nationwide. Nationwide funding for beach nourishment in FY2008, under the Energy and Water Appropriations Bill, remained at the same order of magnitude — that is, ~$101 million (http://www.govtrack.us/congress/). Given the eroded condition of St. Lucie County beaches, the value of properties at risk, the decline of recreation values, and the uncertainty of securing federal appropriations, St. Lucie County is pursuing a locally sponsored beach nourishment project. Goals of the proposed project include shoreline restoration and storm protection as well as restoration of the recreational beach and its associated habitats.

1.3. PROJECT LOCATION

St. Lucie County is located on Florida's east coast about 100 miles north of Miami and 25 miles east of Lake Okeechobee. The project area extends along 3.8 miles of barrier island shoreline on South Hutchinson Island in southern St. Lucie County. The project area comprises two segments: the north segment lies between R-87.7 and R-90.3, and the south segment extends from R-98 south to R-115+1,000 ft (St. Lucie/Martin County line). **Figure 1.3-1** depicts the project area.

The Applicant's preferred offshore borrow area (**Figures 1.3-1** and **2.1-1**) lies in approximately 40 ft of water on the southern portion of St. Lucie Shoal in state waters about 3 miles offshore. The borrow site comprises the landward terminus of the St. Lucie Shoal, which extends north-northeast. The borrow area contains approximately 1.3 million cubic yards (Mcy) of beach compatible material, assuming no dredging deeper than -49 ft NAVD and no dredging within a proposed "refuge patch."

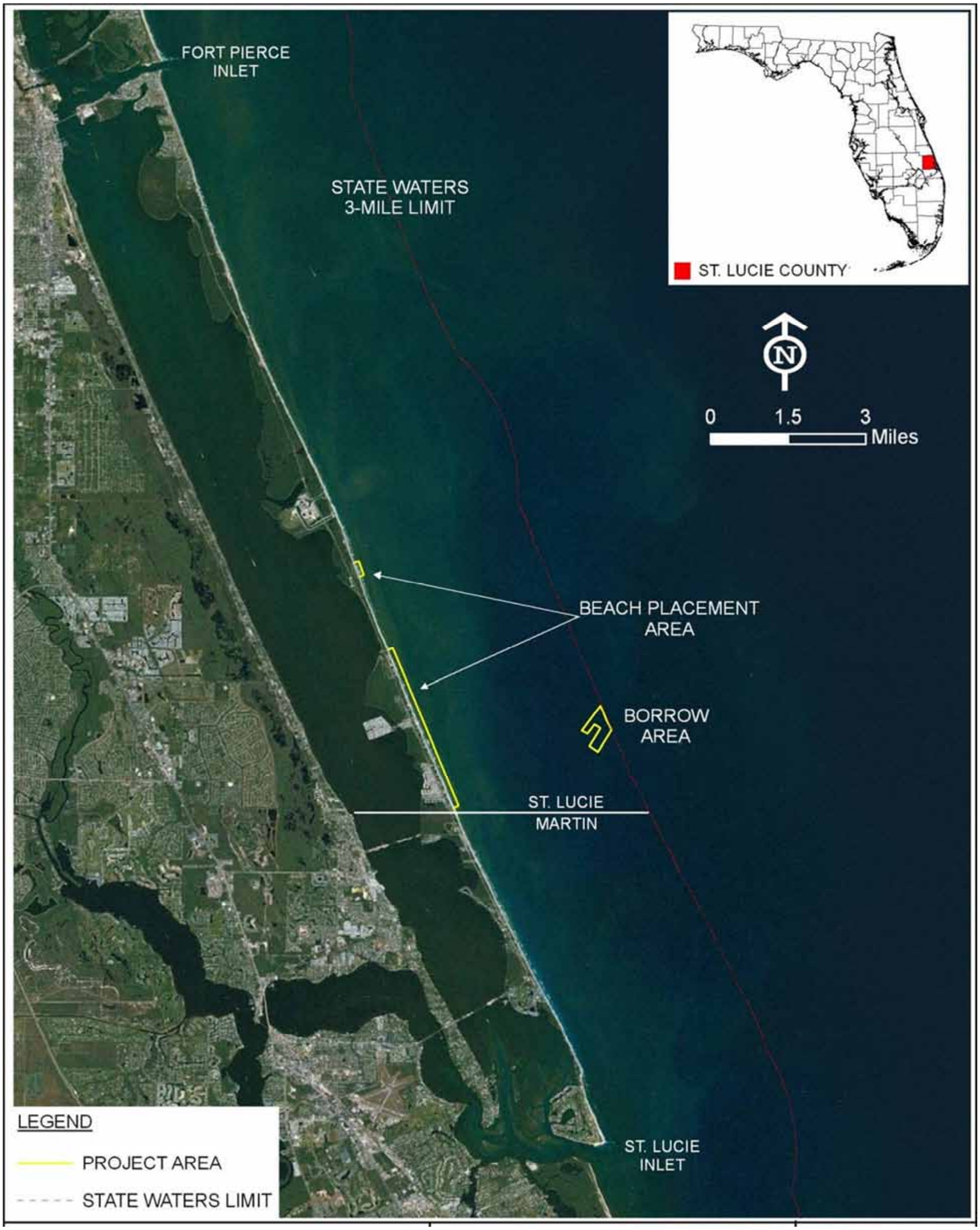

Figure 1.3-1. Project Location, St. Lucie County South Beach and Dune Restoration Project, St. Lucie County, Florida

1.4. ORGANIZATION OF THE DOCUMENT

The content and organization of this DEIS for St. Lucie County follows NEPA requirements. The document includes the following sections:

Summary
1.0 Project Purpose and Need
2.0 Alternatives
3.0 Affected Environment
4.0 Environmental Effects
5.0 List of Preparers and Reviewers
References
Appendices

Various appendices (see enclosed CD) supplement the main text. **Appendix I** includes copies of correspondence, comment letters, and responses to comments received to date. Appendices that supplement the main text include

APPENDIX A	PUBLIC INPUT SUMMARIES AND PUBLIC SCOPING MEETING REPORT
APPENDIX B	DESIGN ALTERNATIVES PLAN AND CROSS SECTION DRAWINGS
APPENDIX C	ADDITIONAL ALTERNATIVES
APPENDIX D	DRAFT MITIGATION PLAN
APPENDIX E	DRAFT PHYSICAL MONITORING PLAN
APPENDIX F	DRAFT BIOLOGICAL MONITORING PLAN
APPENDIX G	DRAFT BIOLOGICAL ASSESSMENT
APPENDIX H	DRAFT ESSENTIAL FISH HABITAT ASSESSMENT
APPENDIX I	PERTINENT CORRESPONDENCE
APPENDIX J	CUMULATIVE EFFECTS ASSESSMENT
APPENDIX K	SECTION 404(B) EVALUATION
APPENDIX L	COASTAL ZONE MANAGEMENT CONSISTENCY DETERMINATION

1.5. AGENCY GOAL OR OBJECTIVE FOR THIS EIS

The objectives of this EIS are to

- Evaluate the existing environmental and socioeconomic conditions and potential future impacts associated with the issuance of CWA permits authorizing shoreline restoration in south St. Lucie County
- Describe and assess alternatives to the proposed beach nourishment project in the project area

1.6. DECISIONS TO BE MADE

The USACE will use the information compiled in this EIS to determine whether it should authorize CWA permits for the purpose of shoreline stabilization in south St. Lucie County. Chapter 2 presents the alternatives under consideration. These alternatives include the No-Action Alternative (i.e., no federal permits issued and no changes to the shoreline's current condition) and five shoreline restoration alternatives.

1.7. APPLICANT GOAL OR OBJECTIVE

St. Lucie County's permit application identifies the following goals and objectives for the South St. Lucie County Beach and Dune Restoration Project:

- Offset historical erosion through beach and dune restoration
- Increase the storm protection function of the beach to protect upland property and infrastructure
- Restore important coastal habitat for wildlife such as sea turtles and shorebirds
- Maintain the recreational capacity of the beach for the public and for commerce

1.8. RELATED ENVIRONMENTAL DOCUMENTS

The EIS reviews and considers numerous reports, technical documents, and studies about the project and project area. The following documents, not cited elsewhere, provided important information related to this EIS.

Bouchard, Richard, P.E, Michael Walther, P.E. and Walker Dawson. 2008. Memo to Paden Woodruff, FDEP Bureau of Beaches & Shores Re: Critically Eroded Beaches & Public Access in South St. Lucie County. June 17, 2008

Brantley, Robert M, Jr., P.E. 2008. Response letter to Memo RE: South Saint Lucie County, Florida - Critically Eroded Beaches June 17, 2008 from Richard Bouchard et al. Florida Department of Environmental Protection, Marjory Stoneman Douglas Building 3900 Commonwealth Boulevard Tallahassee, Florida 32399-3000. 8 December 2008.

CEQ. 1997. *Considering Cumulative Effects Under the National Environmental Policy Act.* Accessed May 2010 at: http://ceq.hss.doe.gov/nepa/ccenepa/ccenepa.htm.

Draft Regional Biological Assessment (RBA) for Beach Activities along the Atlantic and Gulf Coasts of Florida. 2007.

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1.9. SCOPING AND ISSUES

1.9.1. INTRODUCTION

St. Lucie County has developed a long record of public involvement concerning proposed beach nourishment activities in south St. Lucie County. The local public has some familiarity with such involvement, and the county has used that knowledge in developing public understanding and interest in the proposed project. The county has other ongoing beach nourishment projects north of the proposed project area, and adjacent counties have a relatively long history of beach nourishment projects. Over a large portion of the last decade, St. Lucie County has provided significant public access for comment and conceptual input to the south county beach nourishment project. Earlier activities included presentations at regular public meetings and special charettes held by the St. Lucie County Erosion District. The county and its consultants developed pre-application meetings with state and federal regulatory agencies. Most recently, St. Lucie County hosted the USACE scoping meeting for this EIS.

1.9.2. COORDINATION PRIOR TO PUBLICATION OF A NOTICE OF INTENT (NOI) FOR THIS EIS

Since 2006, the Applicant (St. Lucie County Erosion District) has held a series of public information meetings and presentations at regularly scheduled board meetings (conducted by the St. Lucie County Commission) regarding the proposed project. Richard Bouchard, P.E., the county's coastal engineer, has led the presentations and discussions at those meetings, which included presentations and discussions of the scope and status of the proposed project. The county advertises all board meetings that are open to the public.

The county held two planning charettes provided for public input on the conceptual plan. Those meetings and two pre-application meetings comprised major activities of the public input process. **Appendix A** includes summary documentation from the public charettes conducted by St. Lucie County in 2007 and 2009.

A NOI to prepare a DEIS appeared in the Federal Register on April 21, 2010. In addition, the NOI was mailed to interested and affected parties by letter dated April 27, 2010. **Appendix A** provides a copy of the scoping letter, NOI, and letters of comment/response.

To solicit public input while developing the Applicant's preferred plan, the Applicant conducted two public meetings and met with representatives of state and federal agencies (**Table 1.9-1**). Certain elements of the Applicant's preferred plan incorporate recommendations to date from those agencies to facilitate review and approval.

Table 1.9-1. Coordination Meetings Held with Federal and State Regulatory Agencies and with the Public

Date/Location	Agency/Entity and Name(s)	
30 April 2007 St. Lucie County Planning Charette	Private Citizens: St. Lucie County: Coastal Tech:	150 – 200 (approximate attendance count) Richard Bouchard Michael Walthers Walker Dawson
Regulatory Preapplication Meeting 29 May 2007 USACE Palm Beach Gardens Regulatory Office	USACE: NMFS: EPA: St. Lucie County: Coastal Tech:	Penny Cutt Peter Ravella (by phone) Jocelyn Karazsia Audra Livergood (by phone) Tori Foster Richard Bouchard Walker Dawson, Kim Colstad Michael Walthers, and Lois Edwards (by phone)
Regulatory Preapplication Meeting 7 February 2008 Teleconference	FDEP: St. Lucie County: Presidents' Council S. Hutchinson Island: Coastal Tech:	Mike Barnett, Marty Seeling, Ralph Clark, Jennifer Koch, Caitlin Lustic, Becky Prado, and Brian Taylor Richard Bouchard Pat Pacitti Michael Walther, Dilip Barua, Leighann Leanne Budde, Kim Colstad, Walker Dawson, and Lois Edwards
29 April 2009 St. Lucie County Planning Charette	Private Citizens: St. Lucie County: Coastal Tech:	50 – 150 (approximate attendance count) Richard Bouchard Don West Michael Walthers Walker Dawson

1.9.3. EIS PUBLIC INVOLVEMENT

One of the basic tenets of NEPA is that the public and agency officials should receive and comment on comprehensive project information packages before federal agencies make decisions and take actions. In addition, NEPA gives all persons, organizations, and government agencies the right to comment on proposed federal actions that an EIS evaluates. Early identification of issues and potential impacts is critical in order to provide the public with the comprehensive information it needs to comment effectively.

Two information dissemination processes are essential to ensure the public has sufficient access and input to project information: Publication of a NOI and a scoping process. In accordance with federal regulations, the federal agency that makes the decision to prepare an EIS must, in a timely manner, initiate a scoping process for the DEIS and publish a NOI in the federal register. A NOI to prepare an EIS on the St. Lucie County South Beach and Dune Restoration Project appeared in the Federal Register on 21 April 2010. The NOI was widely distributed. The NOI advised the public of the project background, the project purpose, the alternatives that were under consideration, and major issues associated with the project. The NOI also advised the public of the scoping process and invited all parties to participate in the process by identifying any additional concerns, studies needed, alternatives, procedures, and other matters related to the scope of the EIS.

NEPA requires in 40 Code of Federal Regulations (CFR) 1501.7 "… an early and open process for determining the scope of issues to be addressed and for identifying significant issues related to the proposed action." This process, known as the scoping process, must occur before an EIS is prepared. In order to ensure that everyone is heard and that open communication occurs, the USACE holds a *"Public Scoping Meeting*." The USACE uses scoping to ensure that the EIS addresses the concerns of both the public and other governmental agencies. **Appendix A** of this EIS provides the summary report for the EIS scoping process.

As indicated above, the public has provided numerous comments concerning the project at various opportunities provided by the Applicant and USACE between 2007 and 2009. The USACE conducted a public scoping meeting on 19 May 2010. Comments consistently ranged from unqualified support for the project to expressed concerns over any beach nourishment activity. While the county and USACE have received numerous supportive comments, specific concerns have included:

- Protection of the CBRS units in the general project area by omitting so-designated areas from the project
- Repair and replacement of dunes and dune vegetation damaged by erosion
- Impacts to nesting turtles and shorebirds that use the beach
- Concerns with burial of benthic invertebrates on the beach during the nourishment and impacts to benthic invertebrates living in the offshore shoal areas used as a sand source for the nourishment
- Disturbance to fishes living in the nearshore environments (and those that recreational fishermen try to catch) and fishes using the offshore shoals
- Impacts to benthic, hardbottom, and water column habitats both in the nearshore and offshore project areas. These issues included concerns related to effects of physical alterations of offshore shoals recommended by the Applicant as a sand source.
- Long-term implications of repeated nourishments

- Impacts to fishing, diving, surfing, and general water recreation from the placement of sand on the beach
- Desire for additional hard structure to protect the beach (e.g., pep reefs, groins, etc.)
- Sand quality of the sand sources
- The use of local labor and local upland sand to support the county economy rather than the use of imported labor and materials

The Applicant developed the permit application in consideration of the input provided between 2007 and 2009 (personal communication, Richard Bouchard, St. Lucie County coastal engineer; May 2010). Changes made by the USACE in response to comments received during the scoping process included:

- Added analysis of upland sand sources and sand sources in federal waters
- Added project design alternatives associated with the northern project segment (FDEP monument R-87.7 to R-90.3), the use of structures (breakwaters and T-head groins) with and without sand fill. Two of the additional alternatives merited detailed evaluation.

1.9.4. LIST OF STATEMENT RECIPIENTS (DEIS)

Recipients of the DEIS include (in alphabetic order):

Alexander, The Honorable JD, State Senator
Appelson, Gary, Caribbean Conservation Corporation
Atlantis by the Sea Condominium
Barnett, Michael, FDEP, Beaches and Coastal Systems
Bartels, Bill, individual
Beach Club Colony Condo
Beach Club Colony on the Ocean Condo
Bentrott, Jerry, City Manager
Bernhart, David, NMFS-SERO-PRD
Bird, Charlene, individual (Miramar)
Blanchard, Ted, individual (Island Dunes)
Blanchard, Ted, Island Dunes Oceanside Condominium I
Bolgardov, Deborah, Secretary, Princess of Hutchinson Island
Boston, Mark, Florida Alliance for Retired Americans, Inc.
Bouchard, Richard, St. Lucie County
Bowshier, Robert, individual
Brady, Andy, Surfrider Foundation
Bryan, James, Realtor, Ocean Bay Villas Condominium
Cheng, Jenny, FDEP
Collier, Chantal, Coral Reef Program
Costa, Bob and Mary, individuals (Miramar Royal)
Coward, Doug, Vice Chairman, St. Lucie County Commissioner
Cox, Linda W., MBA, SPHR, President/CEO, St. County Chamber of Commerce
Craft, Chris, St. Lucie County Commissioner

Croom, Miles, Nat. Marine Fisheries Serv. Habitat Cons Div.
Cummings, Ken, Manager, Miramar Royale Condominium
D'Avanzo, Ericka, Surfrider Foundation
Daniels, Marvin and Marilyn, individuals (Miramar)
Davy, Kay, NOAA-FS
Degen, Peter, individual (Sandollar Shores)
Delaney, Richard and Anne, individuals
DeMarco, Paul, USACE, Jacksonville District
DeMartini, Jr., Nicholas, individual (Empress)
Diane, Manager, Oceana Oceanfront Condominium II
Dickman, Sandy, Property Manager, Island Crest Condominium
Donhowe, Jim and Karen, Individual (Empress)
Donvan, Cheryl, individual (Claridge by the Sea Condominium)
Doran, Mark and Christy, individuals (Admiral)
Dow, Roxane, FDEP
Dzadovsky, Chris, St. Lucie County Commissioner
Edwards, Lois, Coastal Technology Corporation
Erickson, Tim, individual (Oceana South II Condominium)
Farley, Tom, Property Manager, The Empress Condominium
FDEP, Bureau of Survey and Mapping, Div. of State Lands
FDEP, SE District Branch Office
Fedak, Bob and Sonia, individuals (Empress)
FEMA, Insurance & Mitigation Div.
Fetterman, The Honorable Adam M., State Representative
Fink, Don, (point of contact) Island Beach Club Condominium
Finlay, Mr. and Mrs., individuals (Atlantis)
Finnegan, Colleen, Bureau of Ocean Energy Management, Regulation and Enforcement Leasing Division
Fischer, Edward and Jacquelynn, individuals (The Miramar)
Fitzpatrick, Kathy, Martin County
Flack, Debbie, FSBPA
Florida Shore and Beach Preservation Association
Florida Sportsman
Florida Wildlife Federation
Frolich, Kipp, FWC-Imperiled Species Management
Gelke, John, individual (Miramar)
Gilson, Jr., Thomas, individual (Islandia)
Gilson, Tom, President, Islandia I Condominium
Goldbaum, Lenard, individual
Gorham, Jonathan C., Ph.D., Inwater Research Group, Inc.
Grande, Charles, Chairman, St. Lucie County Commissioner
Gregg, Lisa, FWC
Griffen, Lynn, Florida Coastal Management Program
Gudeman, Stephanie, FDEP
Hageman, Russell, individual (Nettles Island)
Haridopolos, The Honorable Mike, State Senator
Hart, Lynne, individual (Empress)
Harvey, Richard, EPA - South Florida Office

Harvey, Ruth Ann, individual (Empress)
Hastings, Congressman Alcee L.
Hauke, Bill and Carole, individuals (Miramar Royal)
Helton, Jim, individual (Empress)
Hoberg, Chris, Environmental Protection Agency Region IV
Howe, Jeffrey, USFWS
Huebner, James, individual (Regency II)
Hutchinson Island Club Condominium
Island Dunes Oceanside Condominium II
Islandia II Condominium
Janes, Rick, individual (Regency)
Johnson, Steed F., individual (Empress)
Kammerer, Neil, individual
Karazsia, Jocelyn, NOAA Fisheries Service
Kiefer, William and Jaimie, individuals
Komhout, Elizabeth, FDEP
Kosmynin, Vladimir, FDEP
Kotch, Ed, Manager, Oceana Oceanfront Condominium I
Kovacich, Jacquelin, individual
Kraus, Mark, Audubon of Florida
Kryzda, Taryn
Lewis, Paula A., St. Lucie County Commissioner
Lips, Garett, USACE, Palm Beach Gardens
Livergood, Audra, NOAA National Marine Fisheries Service
Logan, Kelly, NOAA-FS
Lynn, Rockwood J., individual (Islandia)
Macloed, Steven, FDEP
Mayfield, The Honorable Debbie, State Representative
Miedema, Ron, USEPA
Milligan, Lauren, Florida State Clearinghouse
Miramar Condominium Association
National Marine Fisheries Service, SE Fisheries Center
Negron, The Honorable Joe, State Senator
Noyes, Richard, FDEP
Oan, Commander, Seventh Coast Guard District
Oberlin, Leah, USACE, Palm Beach Gardens
Ocean Dunes Condominium
Ocean Towers Condominium A
Ocean Towers Condominium B
Oceanrise Condominium
Olsen, Kim, CSA International, Inc.
Outlaw, Faye W., St. Lucie County Administrator
Pacitti, Patricia M., President, Regency Island Dunes
Pelossi, Peter, President, Island Crest Condominium
Piscitelli, Jim, individual (The Miramar Condo)
Poole, Mary Ann, FFWCC
Poppell, The Honorable Ralph, State Representative
Posey, Congressman Bill

Provancha, Jane, Dynamic-Cape Canaveral
Rader, The Honorable Kevin J. G., State Representative
Rank, Robert, individual (Regency)
Recor, David, City Manager
Reefkeeper International
Regency Island Dunes Two
Rooney, Congressman Thomas J.
Root, Vern, Property Manager, The Miramar II Condominium
Sailfish Point Prop Owners
Sand Dollar North
Sand Dollar Shores Condominium
Save the Manatee Club
Schuster, Kathy, Manager, Island Dunes Admiral Condominium
Sea Winds Condominium
Seeling, Martin, FDEP
Shelton, Chuck, individual (Empress)
Shelton, Marie, individual
Sierra Club, Florida Regional Office
Silverman, Allen, Florida Shores and Beach Preservation Association
Singer, Charles W., individual (Island Dunes)
Smith, Doug, Chairman, County Commissioner
Smith, Rodney, Publisher of Coastal Angler Magazine
Snyder, The Honorable William D., State Representative
Souza, Paul, U.S. Fish and Wildlife Service
Spring, Keith, CSA International, Inc.
Steele, Willard, Tribal Historic Preservation Officer, Seminole Tribe of Florida
Storey, George, individual
Strogh, Rick, State Historic Preservation Office
Sutton, Loretta B., Department of the Interior
Talac, Kenneth, individual (Regency II)
Tartamella, Jack and Joyce, individuals (Empress)
Tepper, Craig, Seminole Tribe of Florida
Terry, Steve, Miccosukee Tribe of Indians of Florida
Theriault, Ken, Individual (The Miramar)
Thorson IV, Wayne and Joanne, individuals (Mirrar I)
Trindell, Robbin, FWC
Turtle Reef Club, Turtle Reef Club Condo
USDA – NRCS
Villa Del Sol
Vistana's Beach Club
West, Don, St. Lucie County
Wheatley, Ervin and Joann, individuals (The Miramar Condo)
White, David, The Ocean Conservancy
Wikel, Geoffery, Bureau of Ocean Energy Management, Regulation and Enforcement, Environmental Division
Wilbur, Pace, NMFS-HCD
Williams, Bruce and Thelma, individual (Empress)

1.9.5. COMMENTS RECEIVED AND RESPONSES

The USACE will detail comments received and responses to comments after completion of the DEIS comment period.

1.9.6. ISSUES EVALUATED IN DETAIL

The following issues identified during the EIS scoping period and by the preparers of this Environmental Impact Statement are relevant to the Applicant's preferred plan and appropriate for detailed evaluation:

- Vegetation
- Threatened and Endangered Species
- Hardbottom
- Fish and Wildlife Resources
- Essential Fish Habitat
- Offshore Borrow Area Resources
- Coastal Barrier Resources
- Water Quality
- Hazardous, Toxic, and Radioactive Waste
- Air Quality
- Noise
- Aesthetic Resources
- Recreation Resources
- Navigation
- Historic Properties
- Socioeconomics
- Native Americans
- Drinking Water
- Scientific Resources

1.9.7. IMPACT MEASUREMENT

This DEIS considers the impacts of several beach restoration alternatives on economics, habitats, listed species, and human activities. Metrics include (in no particular order):

- Quantification (development of numeric values for each alternative) where possible
- Qualitative comparison (where quantification is neither possible nor practical)
- Data quality – direct observation, experimentation, or other immediate assessment should receive more weight than evaluation of similar or analogous information. The amount and quality of data also leads to consideration of uncertainty in weighing impacts of alternatives.
- Uncertainty in the understanding of a resource or the level of potential impact of an alternative. Greater uncertainty should equate to a greater impact.

- Expert opinion, if available, particularly in writing
- Public opinion
- Public law, statute, code, and policy

This DEIS is regulatory in nature; the USACE is developing this DEIS as part of Dredge and Fill Permit application review for the proposed project. The level to which each alternative meets the regulatory standards and policies of the federal government agencies is an important component. Because the project affects an important resource to the human population, consideration of public opinion is an important metric for the project. Because the project affects environmental resources, the metrics used on the project must also compare the alternatives at several scales — direct, indirect, and cumulative impacts chief among them.

1.10. PERMITS, LICENSES, AND ENTITLEMENTS

From the State of Florida, the proposed project will require a joint coastal permit (JCP) and authorization to use sovereign submerged lands. The project will also require a dredge and fill permit from the Department of the Army. The BOEMRE may require a lease if dredging occurs on the OCS, which begins three miles from shore.

A JCP application was prepared and submitted to the FDEP and USACE in September 2009. A complete copy of the permit application is available for download at the following website: http://bcs.dep.state.fl.us/env-prmt/st_lucie/pending/.

2. ALTERNATIVES

2.1. DESCRIPTION OF ALTERNATIVES EVALUATED IN DETAIL

This DEIS considers seven alternatives in detail:

8. No-Action Alternative (Status Quo)
9. Beach Fill with No Impact to Existing Hardbottom
10. Beach Fill to Restore the 1972 Beach and Dune
11. Beach Fill to Restore the 1972 Dune with a 35-ft Berm
12. Beach Fill to Restore the 1972 Dune with a 70-ft Berm
13. South Segment Beach and Dune Restoration; North Segment Dune Restoration Only
14. Beach and Dune Restoration with T-head Groins

Coastal Tech provided plan and cross section views of each alternative considered in detail (**Appendices B** and **C**). The following subsections describe each of the alternatives provided by Coastal Tech.

2.1.1. GENERAL DESCRIPTION OF PROJECT CONSTRUCTION

For any alternative including beach fill, potential sand sources will include offshore dredging and upland mines. If an offshore sand source provides the fill, project construction includes three activity phases: dredging, conveyance and pumping of dredged material from the hopper dredge to the beach, and fill grading on the beach. If upland mines provide the fill, truck transport of sand to the beach fill site replaces the dredging and conveyance phase of the offshore sand source alternative. All alternatives considered that include beach and dune construction would use the same construction methods. Sand Source Alternatives (**Section 2.1.6.**) provides detailed descriptions of proposed offshore sand source and upland sand source alternatives. The construction description below focuses on the use of an offshore sand source and the construction activities associated with the dredging and handling of dredged sand.

St. Lucie County has identified an area at the southeast end of St. Lucie Shoal, approximately 3 miles offshore in state waters, as the proposed borrow area (**Figures 1.3-1** and **2.1-1**). Seismic and core boring investigations have indicated that this area contains about 1.3 Mcy of beach quality sand. The site would provide more than sufficient sand for any of the proposed alternatives.

A hopper dredge comprises a self-propelled floating plant capable of dredging material from the ocean bottom, storing it on board, transporting it to a disposal point, and dumping or pumping it to the disposal site. Ocean-going hopper dredges are typically large vessels (>200 ft in length) capable of storing 2,000 cy or more of sediment in their holds. These vessels typically operate on a 24-hours/day, 7-days/week schedule with a crew of several dozen or more. Work boats (likely two or more 35-ft or larger inboard vessels) will transport workers and required materials and supplies to and from the hopper dredge. Periodically, the hopper dredge may return to port for supplies.

During dredging operations, hopper dredges travel at a ground speed of 2 to 3 mph. They can dredge in depths up to about 80 ft and come equipped with twin propellers and twin rudders as well as bow and stern thrusters to provide the required maneuverability. Precise vessel location and elevation are provided by a Real-time Kinematic (RTK) Global Positioning System (GPS) hardware/software system that ensures proper elevation and location control of the dredging activity.

For this project, a hopper dredge will dredge sand by dragging two suctions heads across the approved borrow area. As the material discharges into the ship hold (hopper), sand material falls out of suspension and excess seawater is decanted and discharged overboard. When full, the hopper dredge will move to a location offshore of the beach disposal area and pump the stored sand onto the beach through a submerged pipeline (sub-line) lying on the nearshore ocean bottom and emerging on the beach. The hopper dredge will always locate outside the nearshore hardbottom areas to avoid any impacts to that habitat. At least one and potentially two hopper dredges may work the project to provide continuous sand supply to the beach. The dredger will deploy a sufficient number of vessels to keep the operation running continuously (24 hours/day, 7 days/week).

On the beach, bulldozers will grade the discharged sand to the permitted cross section templates. Two bulldozers typically provide the necessary grading equipment. When necessary, a front-end loader with a rake bucket or similar attachment will connect additional sections of pipeline to allow construction to progress down the beach. In addition to this equipment, a few all-terrain vehicles and one or two pickup trucks provide the typical equipment set associated with a beach construction crew. The site will also typically include a construction shed on a skid, a port-a-potty, and a double-walled fuel tank approved for use in this environment. The contractor may choose to work two locations (two crews) simultaneously as a cost-effective means of operating the project. Lights placed on the beach will allow nighttime work. State and federal permits will specify conditions, including text and drawings defining the required lighting arrangements to avoid and minimize impacts to nesting turtles. An off-beach location will provide space for the beach work crew to park and store some materials.

As necessary, the contractor will extend the discharge pipe along the beach and/or move the location of the sub-line running from the shore to the hopper dredge to pump sand efficiently. Typically, booster pumps are not employed to extend the beach pipeline beyond the capacity of the hopper dredge to pump the sand. For a project as long as this (3.8 mi) with several “no-impact” access points through the nearshore hardbottom zone, the contractor may likely choose to move the location of the sub-line several times. This method allows the contractor to reduce the required total length of shore-parallel discharge pipeline, providing lower equipment costs and easier pumping of the sediments. To construct the sub-line connecting the hopper dredge to the shoreline discharge pipeline, the contractor will connect multiple sections of fabricated pipe at an off-site location. When the sub-line stretches to the desired length, the pipe ends are sealed and the pipe is pressurized to test for leaks. When the pipe passes this test, the contractor floats the pipe into place and sinks it. Divers or a magnetometer survey may verify the final location of the sub-line. The contractor may deploy up to two sub-lines at locations previously identified and approved by the FDEP and USACE for that purpose. Dredge pipeline running along the beach will extend about half of the way between pipeline corridors to the north and south, a maximum of about 3,000 ft, based on proposed and biologically surveyed corridors.

On the beach, the contractor will create a long shore-parallel dike (several hundred feet long) to provide a settling basin for the sand to fall from suspension within the sand-water slurry created to pump the material from the hopper dredge to the beach. Bulldozers continually maintain these dikes and move sand from the settling area into the beach template to maintain the settling basin while shaping the material into the beach template. Maintaining the settling area helps maintain water quality (measured as turbidity) within permitted limits.

If sand from upland mines provides the beach nourishment material, the project will eliminate all in-water activity and pipelines along the beach. Trucks filled at the sand mine will traverse the beach and deposit sand at the necessary location where bulldozers will shape the sand to fill the template. The same set of equipment remains necessary to shape the sand whether discharged through a pipeline or transported with a dump truck.

Planting of salt-tolerant native dune vegetation on the restored dune crest to help stabilize the dune completes the design. Extension of existing public beach access dune walkovers will provide access to the restored beach.

2.1.2. NO-ACTION ALTERNATIVE (STATUS QUO)

The No-Action alternative would allow nature to take its course, i.e., storms will continue to erode the beach and dune, further threaten upland development, and decrease the recreational capacity of the beach.

2.1.3. BEACH FILL WITH NO IMPACT TO EXISTING HARDBOTTOM

The construction profile for this alternative comprises a dune restoration with an additional average crest width of about 23 ft (width range 0 to 52 ft, location dependent) at an elevation of +12.5 ft NAVD, a landward slope on the restored dune face of 3H:1V (where applicable), and a seaward dune face slope of 3H:1V to approximately +7.5 ft NAVD. From the toe of the restored dune, the fill would slope seaward to the existing grade at 10H:1V. Based on an August 2008 survey, the intersection of the constructed dune and surveyed surface ranges from +8 to +14 ft NAVD. The design also includes a 1,000-ft template tapered back to the R-monument line at the beginning and end of the north and south project sections. Planting of salt-tolerant native dune vegetation on the restored dune crest will support long-term maintenance of the dune. This alternative includes no hardbottom impacts. **Appendix B** provides plan and cross section views of this design alternative.

The Beach Fill with No Impact to Existing Hardbottom yields only a minimal fill project with a very low fill density (8.1 cy/ft) and a total volume of 162,174 cy. The relatively low density and total volume of this alternative would likely allow trucking the sand (a “truck haul” project) as a construction option as an alternative to the St. Lucie Shoal offshore borrow area.

2.1.4. BEACH FILL TO RESTORE THE 1972 BEACH AND DUNE

The construction template for this alternative comprises a dune restoration with an added average crest width of about 30 ft (range 9 to 52 ft, location dependent) at an elevation of +12.5 ft NAVD, a landward slope on the restored dune face of 3H:1V (where appropriate), and a seaward restored dune face slop of 3H:1V to approximately +7.5 ft NAVD. From that point seaward, the fill slopes at 10H:1V to the sediment interface. The design also includes a 1,000-ft template tapered back to the R-monument line at the beginning and end of the north and south project sections. Planting of salt-tolerant native dune vegetation on the restored dune crest will support long-term maintenance of the dune. This alternative would impact about 0.14 acres of nearshore hardbottom habitat. **Appendix B** provides plan and cross section views of the design alternative.

The Beach Fill to Restore the 1972 Beach and Dune alternative yields a project with a very low fill density (10.5 cy/ft) and a total fill volume of 209,249 cy. This alternative might allow construction using an upland sand source and truck haul to supply the sand as an alternative to the St. Lucie Shoal offshore borrow area.

2.1.5. BEACH FILL TO RESTORE THE 1972 DUNE WITH A 35-FT BERM (APPLICANT’S PREFERRED PLAN)

This beach and dune restoration project alternative consists of a dune restoration with an added average crest width of about 38 ft (range 59-67 ft) at an elevation of +12.5 ft NAVD. The landward slope on the restored dune face lies at 3H:1V (where applicable); the same slope on the seaward face of the restored dune face extends seaward to elevation +5.35 ft NAVD (the restored dune toe). The beach berm extends 35 ft seaward from the toe of the restored dune at a 100H:1V top slope and ties to the existing grade with a 10H:1V seaward face slope. A seaward extension of about 25 ft of the beach berm at the same 100H:1V top slope and 10H:1V seaward face slope provides “advance” fill to offset expected future erosion.

This alternative would require approximate 610,000 cy of fill with an average fill density of 30.5 cy/ft. An offshore sand source would provide the most likely means of sand supply for this alternative.

Impacts of this alternative would include 1.08 acres of nearshore hardbottom habitat, primarily in the northern segment of the project area (R-87.7 to R-90.3). **Appendix B** provides plan and cross section views of the design alternative.

2.1.6. BEACH FILL TO RESTORE THE 1972 DUNE WITH A 70-FT BERM

This beach and dune restoration project alternative consists of a dune restoration with an added average crest width of about 33 ft (range 59-67 ft) at an elevation of +12.5 ft NAVD. The landward slope on the restored dune face lies at 3H:1V (where applicable); the same slope on the seaward face of the restored dune face extends seaward to elevation +5.35 ft NAVD (the restored dune toe). The beach berm extends 70 ft seaward from the toe of the restored dune at a 100H:1V top slope and ties in to the existing grade with a 10H:1V seaward face slope. A seaward extension of about 25 ft of the beach berm at the same 100H:1V top slope and 10H:1V seaward face slope provides “advance” fill to offset expected future erosion. Planting of salt-tolerant native dune vegetation on the restored dune crest to help stabilize the dune completes the design. In addition, extension of existing public beach access dune walk-overs will provide access to the restored beach. The alternative would impact approximately 1.34 acres of hardbottom, primarily in the northern segment of the project area (R-87.7 to R-90.3). **Appendix B** provides plan and cross section views of this design alternative.

The Beach Fill to Restore the 1972 Dune with a 70-ft Berm alternative would require approximately 899,600 cy and entail an average fill density of approximately 44.9 cy/ft.

2.1.7. SOUTH SEGMENT BEACH AND DUNE RESTORATION; NORTH SEGMENT DUNE RESTORATION ONLY (NORTH SEGMENT DUNE RESTORATION ONLY)

The north segment of the project consists of a relatively short beach length (R-87.7 to R-90.3; ~2,600 ft) compared to the south segment that extends from R-98 to R115+1,000 (about 18,000 ft). The short north segment, separated from the larger south segment by approximately 7,700 ft, will erode at a higher rate than the south segment. Accordingly, a thorough evaluation of project performance must compare alternatives with beach fill and without beach fill (dune restoration only) in the north segment. **Appendix C** provides a detailed comparison of changes in project beach widths over time with and without beach fill in the north segment.

The short length of the north segment and large adjacent gap without beach fill causes the north segment beach fill to experience much more rapid erosion following project construction compared to the south segment (between R-98 and R-115+1,000). The Department of Natural Resources Beaches and Shores (DNRBS) modeling results for the “Beach Fill with 35’ Berm” alternative (**Appendix C: Figure 2.1**) demonstrate the more rapid erosion of the 1-year shoreline in the north segment as compared to the south segment. However, the 1-year and 10-year shoreline positions in the north segment differ by less than 10 ft because of the fill dispersion from the south segment.

By comparison, DNRBS modeling of North Segment Dune Restoration Only alternative shows that the northern segment features minimal additional berm width for the 1-yr shoreline and approximately 15 ft of additional berm width for the 10-yr shoreline (**Appendix C: Figure 2.4**). This results from dispersion of material from the south segment to the north (as well as south) following project construction. Over time, the north segment shoreline width increases as the south shoreline width decreases. Ten years post-construction, the north segment beach has about the same beach width whether or not it received beach fill (compare **Appendix C: Figures 2.1** and **2.4**).

The North Segment Dune Restoration Only alternative eliminates hardbottom impacts from the north segment template. Compared to the Applicant's preferred alternative, the North Segment Dune Restoration Only alternative reduces hardbottom impacts from 1.08 acres to 0.07 acre.

The North Segment Dune Restoration Only alternative provides a reduced level of protection on the north segment beach compared to the alternatives that include beach fill within the north segment. However, DNRBS modeling results predict that over time, the north segment beach width increases due to dispersion of sand from the south segment of the project. The gradual increase in beach width over time provides an increasing level of protection along the north segment. By the tenth year, the north segment beach width approaches the beach width of the south segment (**Appendix C: Figure 2.4**).

2.1.8. BEACH AND DUNE RESTORATION WITH T-HEAD GROINS

During the scoping process for this EIS, regulatory agency staffs identified two alternatives that included beach fill with either breakwaters or groins. The potential benefit of structures in addition to beach fill focused on longer retention of the beach fill.

Unlike beach nourishment, hard structures do not add sand to the littoral system. Any sand accumulated by a hard structure such as a breakwater or groin results in erosion at another (typically downdrift) location. Exceptions to this generalization include structures located on the downdrift sides of inlets or significant natural promontory features. These locations form semi-contained littoral cells that generally isolate themselves from other larger littoral system cells. In these areas, the use of structures with additional fill often provides a cost-effective means to maintain a beach without the offset erosive consequence described above. The use of hard structures in the middle of a long littoral system generally does not result in net benefits equal to or greater than those of sand placement alone. However, structures in combination with nourishment could provide a means to achieve the project objectives. This EIS considers two hard structure alternatives: breakwaters and T-head groins, each with beach nourishment. Consideration of beach nourishment with breakwaters led to a decision that the beach nourishment with breakwaters alternative should not receive detailed evaluation (see **Section 2.4.12.** below).

T-head groin structures consist of a shore-perpendicular structure (e.g., groin) with a shore-parallel breakwater at the seaward end. Many projects feature multiple T-head groins located along the shoreline. T-head groins offer benefits over traditional groins (those without shore parallel "heads"). T-head groins require a shorter shore-perpendicular length to hold the same shoreline position (Hanson and Kraus 2001) and the shorter length requires less armor stone (rock). Having a shorter shore-perpendicular length, the structures reduce potential hardbottom impacts. Additionally, the "head" section at the seaward end of the groin can significantly reduce offshore losses of sand. Optimization of the head section to match the predominant incident wave angle can improve project performance — shoreline stabilization and fill retention (Bodge 1998). Concerns over recreational activities near the T-head structures and aesthetics can counter the benefits of increased shore stabilization and beach fill retention. Some groups have suggested that T-head structures, like breakwaters, also cause detrimental impacts to marine turtles.

T-head groins with beach fill to “pre-fill” the compartments between the groins provide a viable coastal engineering solution to counter certain erosive conditions. These conditions typically locate downdrift of existing coastal structures or in areas that feature a sediment transport reversal or deceleration in transport volume. For “open coast” areas with generally uniform sediment transport (such as the proposed project beach), a T-head groin system would likely cause accretion on the updrift side and erosion on the downdrift side. As the structures themselves do not add any sediment to the system, any accretion (volume gain) caused by the structures must induce an equal amount of erosion (volume loss) at another location. In effect, T-heads groins will likely translate the erosion problem further downdrift. However, in many cases, periodic renourishment and modification of the structure’s design can mitigate for the downdrift erosion.

Specific to the south St. Lucie County project, T-head groins with beach fill could meet the project goals to increase storm protection, restore important coastal habitat for wildlife, and maintain recreational capacity of the beach. However, T-head groins could shift erosion to adjacent downdrift locations, negatively impact recreational activity on the beach, and reduce access to nesting and recently hatched sea turtles. The T-head groin footprint would directly impact approximately 0.05 acre of hardbottom (personal communication, Lois Edwards, Coastal Tech, October 2010). Similar impacts and benefits of a groin field would associate with each of the proposed dune and beach template. The groin design would scale to the desired beach width.

The applicant provided an analysis of a T-head groin alternative associated with the 35-ft berm design for general understanding of this alternative. A T-head groin design, similar to the T-head groins under consideration by St. Lucie County for shoreline immediately south of Ft. Pierce Inlet (Olsen Associates 2009), provided the basis for consideration of this alternative. The groins, sized from empirical methods (Bodge 1998), were designed to maintain the design mean high water line (MHWL) for the equilibrated beach fill design.

Each of the T-head groins would have the following characteristics:

- Shore normal length of 275 ft extending from approximately 50 ft landward of the existing +3.0 ft NAVD contour to about 190 ft seaward of the design MHWL
- Crest elevation of +3.0 ft NAVD
- A seaward slope of 3H:1V from +3.0 ft NAVD out to a depth of approximately -5 ft NAVD
- Alongshore spacing of 200 ft (between the ends of the T-Heads)
- A “head” extending about 205 ft shore-parallel

Beach nourishment would accompany groin construction. Assuming that the groin system would apply to the Applicant's preferred beach fill alternative (1972 dune with 35-ft berm), the required fill template and volumes would not change.

Based on hardbottom visible in 2008 aerial photographs, groins plus fill would impact 1.13 acres of hardbottom compared to 1.08 acres of impact for the Applicant's preferred alternative (personal communication, Lois Edwards, Coastal Tech, October 2010).

The proposed project area could require as many as 25 groins with an estimated total cost of $14.2M (Coastal Tech 2010a). These costs, added to the beach fill cost estimate ($8.85M excluding hardbottom mitigation), would result in a project cost of $23.05M and an increased mitigation cost proportional to the increase in area of impact.

When groins perform as designed, they capture sand and increase erosion of the downdrift beach by preventing an equivalent volume of captured sand from moving into the downdrift beach. Beach fill is therefore necessary to offset the predicted volume of sand the groins would capture. The fill would replace the sand that the T-head groin would otherwise capture, eliminating the downdrift losses. During storms, groins could retain sand in the project area, but the volume of sand retained would likely erode from downdrift beaches. Thus, presence of groins in the project area could require periodic fill of downstream beaches to offset this effect.

Florida Administrative Code (F.A.C.) identifies the conditions for state acceptance of structures such as groins or breakwaters. FDEP rules [62B-41.005(5), F.A.C.] prescribe that

> *Structures which interfere with the natural longshore and onshore/offshore movement of sediments shall not be allowed unless a net positive benefit to the coastal system can reasonably be expected to occur and mitigation is provided for any adverse impacts which may occur to the coastal system.*

Based on these rules, FDEP permits for groins require mitigation in the form of fill placement on the downdrift beaches to offset the sand they trap. FDEP rules assume that groins would not decrease beach nourishment requirements as any volume of trapped sand will erode the downdrift beaches and require mitigation by placement of an equivalent volume of sand. In this case, the immediate downdrift beach comprises the Martin County Shore Protection Project.

2.1.9. SAND SOURCE ALTERNATIVES

As part of the initial USACE permit application for the proposed project, St. Lucie County presented two sand source alternatives. The first alternative (the Applicant's preferred alternative) comprises a borrow area located approximately three miles offshore in state waters (**Figure 1.3-1**). The EIS scoping process identified two additional sources: upland sand sources from mines in St. Lucie county and elsewhere,, and an offshore source from a location in federal waters offshore of the county. The second source, the borrow area currently proposed by the USACE for use in the Martin

County Shore Protection Project, is the subject of a Supplemental Environmental Impact Statement for that federal project.

St. Lucie County has also proposed the use of offshore sand shoals (largely in federal waters) as a long-term source of nourishment sand (see Coastal Tech 2009: Design Document) and Taylor Engineering (2009) for a description of offshore sand sources in the county's offshore waters).

2.1.9.1. Sand Quality

Beach placement material must comply with the "sand rule" specified in Florida Administrative Code, Rule 62B-41.007(2)(j) and summarized in **Table 2.1-1**. These broad characteristics apply to all beaches in Florida. In addition, sand used for beach placement material must closely resemble the "native" sand (that exists now or at some time past when sand quality was first characterized) for biological, physical, and aesthetical purposes; these conditions may give rise to more stringent quality limits than those shown in **Table 2.1-1**. Offshore sources must meet these standards, as material processing to alter sand quality is not cost-effective. Upland mines often have the capability to process their material to meet a given set of standards. No additional standards exist for qualifying upland sand source material (as compared to other sources) for beach fill use (Taylor Engineering 2007).

Table 2.1-1. Florida Administrative Code Characteristics of Sand Placed on Beaches

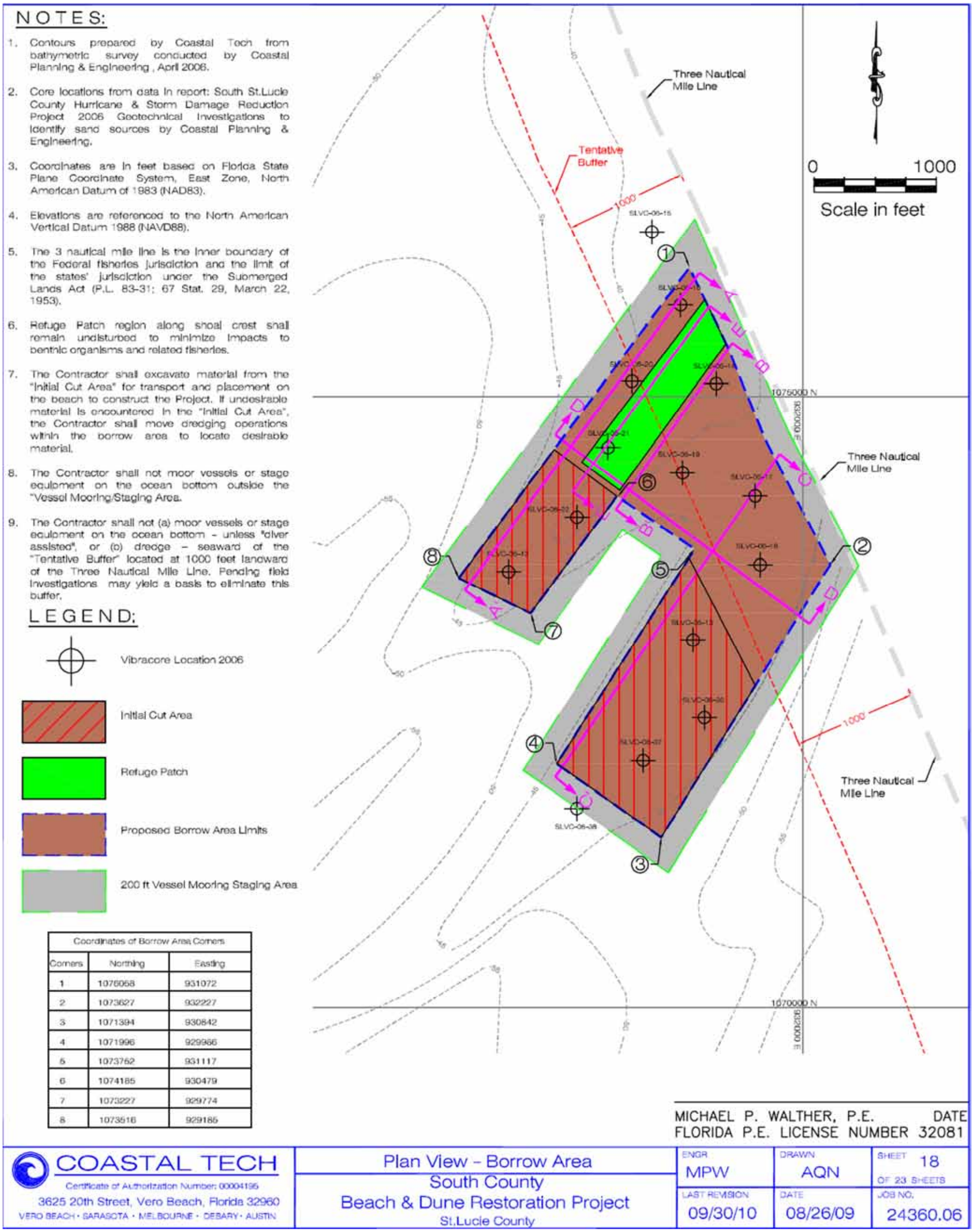
Sand Source Sediment Characteristic	Absolute Limits for Placement on Florida Beaches
Composite grain size	Particle size distribution ranging between 0.062mm (4.0f) and 4.76mm (-2.25f) (classified as sand by either the Unified Soils or the Wentworth classification) similar in … grain size distribution (sand grain frequency, mean and median grain size and sorting coefficient) to the material in the existing coastal system at the disposal site
Composite Munsell color	Similar in color
Silt content (passing through sieve #230)	No more than 5% by weight in composite
Gravel content (passing through sieve #4)	No more than 5% by weight in composite
Coarse gravel (retained on ¾" sieve)	None in any sample greater than found on the native beach
Construction debris, toxic material, foreign matter	None in any sample
Material resulting in beach cementation	None in any sample

2.1.9.2. Sand Sources in State Waters

Coastal Tech (2009: Design Document) identified the extreme south end of the St. Lucie Shoals, located in state waters approximately 3 miles offshore the project beach (**Figure 1.3-1** and **Figure 2.1-1**), as a proposed source of sand for the project. The county selected the site based on geotechnical investigations reported in Coastal Planning & Engineering (2006). The selected area contains about 1.3 Mcy of beach compatible material, available by dredging to a maximum depth of about 10 ft below the existing surface. The dredging design includes initial cut areas that should provide sufficient sand (610,000 cy). Volume estimates (Coastal Tech 2009: Design Document) included the FDEP-required 2-ft buffer at the bottom of the dredge cut and buffers around magnetic anomalies.

The existing project beach sand has a composite mean grain size of 0.49 mm. The composite of sand sampled from the proposed borrow area has a mean grain-size of 0.43 mm. The initial cut area sand samples showed a composite grain size of 0.42 mm and a median of 0.36 mm. The well-sorted borrow area sand contains <1% shell and 1.6% fines. These characteristics meet state standards for placing the sand on the project beach.

Should the sand quality require dredging of additional areas, the plan would require that dredging begin in areas farthest from the highest elevations. The dredging design



Coordinates of Borrow Area Corners		
Corners	Northing	Easting
1	1076058	931072
2	1073627	932227
3	1071394	930842
4	1071996	929966
5	1073762	931117
6	1074185	930479
7	1073227	929774
8	1073516	929185

Figure 2.1-1. Proposed Borrow Area within State Waters, St. Lucie County South Beach and Dune Restoration Project

avoids and preserves the highest areas of the shoal to retain refuge areas for shoal fauna, as recommended by Diaz et al. (2003) and CSA International Inc. et al. (2009).

2.1.9.3. Sand Sources in Federal Waters

Atlantic Ocean waters under sole jurisdiction of the federal government begin 3 miles off the coast of Florida (and extend 12 nautical miles from the Atlantic Coast shoreline). Taylor Engineering (2009) detailed available sand resources in this region of the Atlantic Ocean off Florida counties south of Cape Canaveral (off the shores of Brevard, Indian River, St. Lucie, Martin, Palm Beach, Broward, and Miami-Dade counties). St. Lucie County has identified 51 Mcy of potential sand in borrow areas located in the St. Lucie Shoal, also in federal waters (**Figure 2.1-2**), but proposes to use the very southwest end of the St. Lucie Shoal, located in state waters, for the proposed project. St. Lucie County is considering sources in federal waters for the 50-year project life. Coastal Tech (2009: Design Document) estimated a project renourishment interval of about 10 years for a project requiring 200,000 cy.

Access to resources in federal waters requires a lease with the BOEMRE. The USACE has requested BOEMRE (and BOEMRE as agreed) to act as a cooperating agency for the South St. Lucie County Beach and Dune Restoration Project EIS (**Appendix I**). With BOEMRE as a cooperating agency for this EIS, St. Lucie County should experience a streamlined lease process in the future if it elects to access sand resources in federal waters. However, as the county can begin the federal lease process only after publication of the Record of Decision for the EIS, acquisition of a federal lease would significantly delay the project. Project delay could result in loss of grant monies that will make the project financially possible. The county therefore intends to use sand from state waters for the currently proposed project. Future beach restoration for a 50-year project could use sand from federal waters.

2.1.9.4. Upland Sand Sources

Upland sand sources have provided sand for beach nourishment projects in Florida for over a decade. They have sometimes provided a cost-effective alternative to offshore dredging, particularly for small projects (less than 50,000 cy) (USACE 2001) and have recently provided the primary source for larger projects in Indian River County and Brevard County. As offshore sand resources along the east coast of Florida start to dwindle, upland sources appear increasingly attractive (Taylor Engineering 2009). Taylor Engineering (2007) explored the possible use of upland sand mines for beach nourishment projects in St. Lucie County.

Beach restoration projects using upland sand have shown mixed results. A 2004 project constructed in St. Lucie County with upland sand resulted in material cementation on the beach. In that case, unwashed sand could have accounted for the observed chemical processes that occurred. By contrast, Indian River County has successfully nourished its beaches with washed upland sand. As a result, FDEP has recommended that upland suppliers wash all sand used in beach projects (Taylor Engineering 2007).

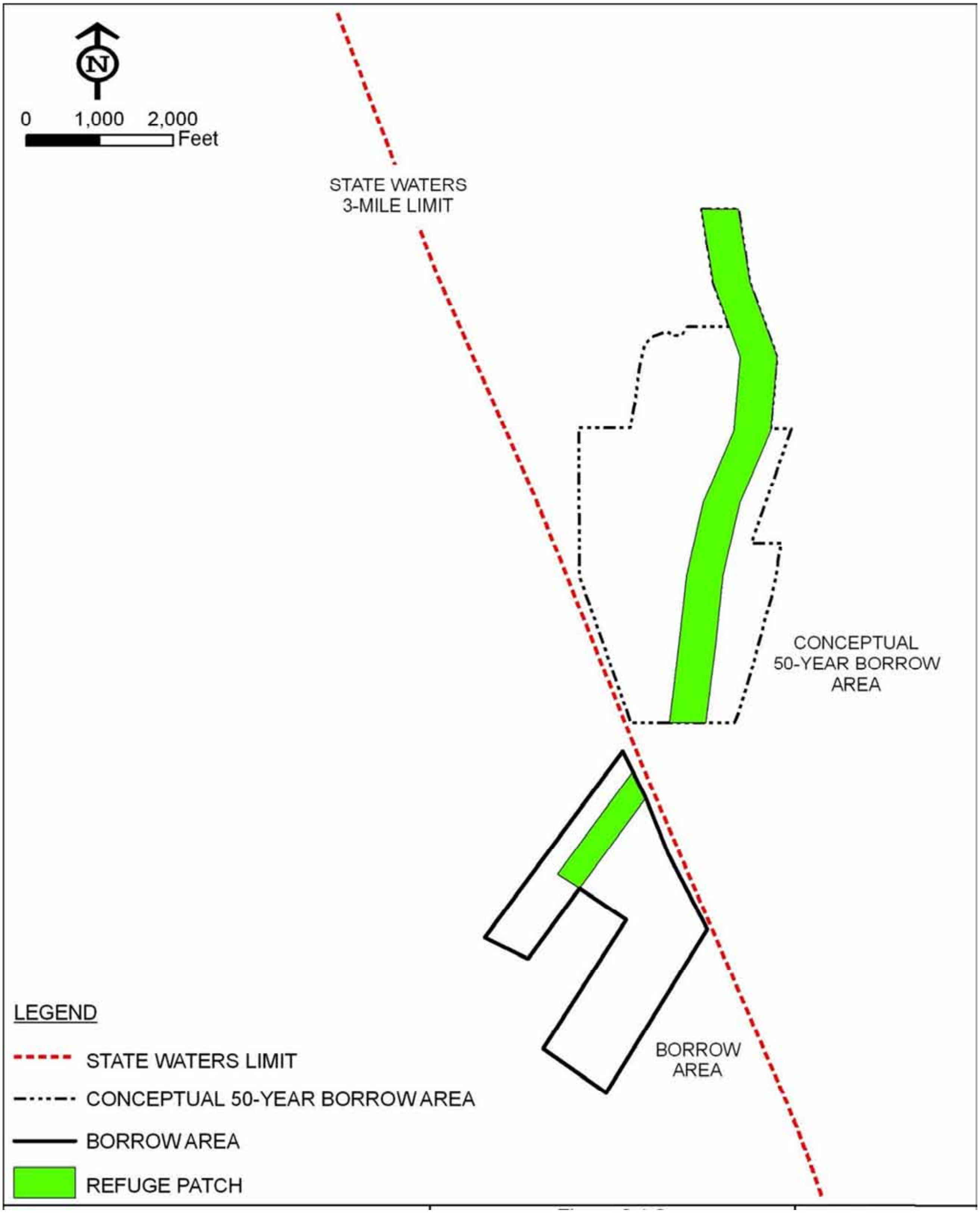


Figure 2.1-2. Offshore Borrow Area and Conceptual 50-year Borrow Area, St. Lucie County South Beach and Dune Restoration Project

Many upland borrow sources in Florida produce sand by crushing limestone rock. The resultant material cannot serve as beach fill because its angular grains tend to compact over time (USACE 2001). In this document, “sand from upland mines” refers to natural, non-manufactured sand that will arrive at the beach in dump trucks. However, the mine may have to wash and grade the sand in order to create beach quality sand characteristics from the raw material.

Although St. Lucie County views the offshore sand in state waters as the preferred source for the proposed project, maintaining the option of upland sand use would allow the greatest flexibility in project planning. Understanding the effect of upland sand use on project execution, and comparing the project impacts of upland versus offshore sand source use provides a means to assess the overall potential for upland sand source use as part of the South St. Lucie South Beach and Dune Restoration Project.

2.1.9.4(a). Upland Sand Source Locations

Taylor Engineering (2007) identified 14 upland sand sources within 150 miles of the project location in south St. Lucie County (**Table 2.1-2** and **Figure 2.1-3**). St. Lucie County currently contracts with three firms using three of the mines (**Table 2.1-2**: Stewart, Fischer 86th and Ranch Road Mines) that can provide acceptable beach-quality sand for the South St. Lucie County Beach and Dune Restoration Project (personal communication, Lois Edwards, Coastal Tech, November 2010). Before tapping any source, St. Lucie County must submit laboratory reports to FDEP documenting the sand quality and additional documentation to detail available volumes of acceptable quality sand.

2.1.9.4(b). Sand Purchase and Delivery

St. Lucie County has awarded contracts for the supply, transportation, and placement of suitable upland beach compatible sand for emergency beach and dune restoration following future storm events in St. Lucie County. The county could also retain transport companies unaffiliated with any specific materials contractor. These companies generally include trucking companies with various offices around the state and a fleet of trucks, which haul material within regional boundaries. Many companies with smaller truck fleets appear somewhat apprehensive when offering services for a beach fill project. Their businesses cannot sustain a large job without intermediate payment.

Many transport companies have relationships with construction contractors that offer material placement services. Often the construction contractors offer a discounted price to use a transport/placement service, especially when considering a highly established business with generous resources. Although the county can work independently to contract a separate supplier, transporter, and placement service provider, it may find working within the pre-established partnerships economically beneficial.

Figure 2.1-3. Upland Sand Mine Locations, St. Lucie County South Beach and Dune Restoration Project

Table 2.1-2. Upland Sand Sources

Mine	Address	City	Zip	County	Distance from Project (Est. Miles)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)
Palm City Sand	1790 SW Poma Drive	Palm City	34990	Martin	15	27.1735	-80.248
Indiantown	West Farms Road	Indiantown	34956	Martin	25	27.0315	-80.5108
Stewart Mine* (Indrio Pit)	13575 Indrio Road	Ft. Pierce	34945	St. Lucie	27	27.5218	-80.462
Dickerson's Indrio Pit	14885 W. Indrio Road	Ft. Pierce	34945	St. Lucie	27	27.5218	-80.4805
Fischer 86th*	1900 86th Ave SW	Vero Beach	32968	Indian River	33	27.5779	-80.5010
Ranch Road*	5915 82nd Ave/Co Road 619	Vero Beach	32960	Indian River	39	27.70307	-80.4979
Palm Beach Aggregates	20125 Southern Blvd.	Loxahatchee	33470	Palm Beach	43	26.6856	-80.3721
Star Pit	12201 US Hwy 27 S	South Bay	33493	Palm Beach	66	26.5046	-80.6696
Palmdale Sand Mine	5990 U.S. Highway 27 Northwest	Palmdale	33944	Glades	70	26.9161	-81.2711
Witherspoon Sand Plant	11655 W SR 78	Moore Haven	33471	Glades	73	26.813	-81.2786
E.R. Jahna Mine (Ortona Sand Mine)	12535 W SR 78	Moore Haven	33471	Glades	74	26.8159	-81.2965
Lake Wales Sand Mine	534 Story Road	Lake Wales	33859	Polk	90	27.9019	-81.5061
Gator Sand Mine	2200 Dean Still Road	Davenport	33868	Polk	114	28.2764	-81.7056
474 Sand Mine	11945 County Road 474	Clermont	34714	Lake	114	28.3579	-81.6509

* Local sand mines with beach-quality sand contracted by St. Lucie County (personal communication, Lois Edwards, Coastal Tech, November 2010)

2.1.9.4(c). Sand Transport and Placement

Trucks loaded at the mines would haul the sand in truckloads of 20 cubic yards, the maximum allowed by state law (Taylor Engineering 2007), to staging areas adjacent to the project beach. Potential beachfront staging areas (**Table 2.1-3**) for offloading sand hauled from the mines before distribution and placement of sand on the beach include county-owned parks in the project area. The St. Lucie County Office of the Property Appraiser website (http://www.paslc.org/) provided the zoning classification of each park.

Table 2.1-3. Potential Upland Sand Source Staging Locations within Public Parks

Park Name	R-Monument Location	Zoning
Walton Rocks Beach Park	R-86	Residential Conservation (R/C)
Normandy Beach Park	R-98	Institutional (I)
Dollman Beach Park	R-102	Conservation Public (CPUB)
Waveland Park	R-111	Conservation Public (CPUB)

Staging areas provide space to transfer fill material from road-trucks to off-road-trucks and short-term storage of materials. Off-road-trucks would move the fill material from the staging areas to the beach and dump the sand within the construction template for grading by bulldozers and/or front-end loaders to appropriate template elevations. The contractor might also use staging areas for temporary storage of equipment during construction. All equipment maintenance would occur off site. The contractor would manage activities to minimize disruption to traffic into the staging areas, as these public properties provide the primary public access to the Hutchinson Island shoreline for many residents and visitors.

2.1.9.4(d). Project Schedule

Fill placement would occur between November 1 and May 1 (outside the peak turtle nesting season) as would the project using any other source of sand. A construction period of 120 – 160 days (November 1 – March 1 or November 1 – May 1) would provide time to transport and place 30,500 truckloads of 20 cubic yards per truck. A construction period of 120 days would require transport, placement, and grading a daily average of at least 5,200 cubic yards of material (260 truckloads) within the project area. St. Lucie County has indicated that “based on experience with the Indian River County Sector 3 Beach and Dune Restoration Project, the above daily production is feasible with the contractor working only during daylight hours” (personal communication, Lois Edwards, Coastal Tech, November 2010). In comparison, use of the offshore sand source would likely require fewer than 90 days to complete fill placement activities.

2.1.9.4(e). Opinion of Probable Costs

Table 2.1-4 shows the project cost differences between using an offshore or upland sand source based on the Applicant's preferred alternative. Cost information to develop the opinion of probable cost included information provided by Coastal Tech (2010b: Design Document: Appendix C: Benefit Cost Analysis) for an offshore sand source, costs associated with existing contracts for sand fill held by St. Lucie County (data provided by Lois Edwards, Coastal Tech, 23 November 2010), and recent St. Lucie County costs for beach tilling (personal communication, Richard Bouchard, St. Lucie County, January 2011).

Table 2.1-4. Opinion of Probable Costs for Using Offshore and Upland Sand Sources

Item	Description	Sand Source	Quantity	Unit Price	Cost
1	Mobilization / Demobilization	Offshore	1 LS	$2,075,000	$2,075,000
		Upland	1 LS	$10,166	$10,166
2	Furnish and Install Sand	Offshore	610,000 cy	$10.07	$6,142,700
		Upland	610,000 cy	$22.48	$13,712,800
3	Permit Compliance	Offshore	1 LS	$140,000	$140,000
		Upland	1 LS	$292,000	$292,000
4	Beach Tilling	Both	1 LS	$50,000	$50,000
5	Furnish and Install Plants	Both	440,000 plants	$0.90	$396,000
6	Mitigation Reef	Both	1.08 acres	$500,000	$540,000
7	Site Restoration	Both	4 each	$3,500	$14,000
Total Construction Cost		**Offshore**			**$9,357,700**
		Upland			**$15,014,966**

2.1.9.4(f). Cost Comparison

Compared to an offshore sand source, use of upland sand sources for the Applicant's preferred alternative would increase the total project cost by about $5.7 million, or 60%. Cost differences accrue primarily due to the difference between offshore and upland sand delivery and installation costs (**Table 2.1-4**). The delivery method (hopper dredge or truck) accounts for most of the difference. Actual bids for sand supply (offshore or upland) are very sensitive to the state of the industry (amount of ongoing work involving dredging or trucking of sand) and key cost components such as fuel. Thus actual coast may vary significantly. In 2011, St. Lucie County paid about $20/cy for 65,000 cy of trucked sand placed in an emergency nourishment project immediately south of Ft. Pierce Inlet. For the 2009 Ft. Pierce Shore Protection Project renourishment, the unit cost for sand dredged from an offshore source was slightly less than the unit cost presented in **Table 2.1-4**.

For the offshore sand source, the county might realize an additional cost savings via a potential "regional project" with Martin County through the FDEP's Beach Erosion Control Program. In that case, a single sand source (and contractor) would serve both construction projects. In addition, a "regional project' would likely enhance the performance of both projects, as such an effort would result in a single nourishment project almost eight miles in length and positively impact the longevity of both projects.

2.1.9.4(g). Comparison of Impacts Related to Sand Source

Reduced impacts to offshore borrow areas comprise the most significant difference between the use of an upland and offshore sand source. Use of upland sand as a partial or total source of sand would result in the dredging of less or no sand from the proposed sand shoal borrow area. The ecological benefits provided by sand shoals offshore the Florida coast has received little study but may include a variety of important functions for a range of marine species (Gilmore 2009). The lack of understanding of shoal functions suggests cautious use of these non-renewable resources.

The anticipated impacts of the project template to dune, beach, and nearshore resources associated with use of an upland sand source are almost identical to those anticipated with use of an offshore sand source. The impacts associated with filling the nourishment template remain the same. The potential impacts associated with pipeline corridors to move sand from the hopper dredge to shore are small in extent but would not occur with use of an upland source.

A contractor using an upland sand source would require about the same construction ingress/egress route(s) and slightly larger beachside staging areas than those necessary when using offshore sand sources. Therefore, impacts associated with these project components could increase slightly compared to the offshore sand source. However, these impacts occur in the upland area and remain relatively minor regardless of the sand source. In addition, both upland and offshore sources will temporarily (a) discourage birds from using the fill site during construction and (b) pose safety concerns for the public using the fill site for walking, fishing, sunning, and surfing.

Truck haul through urban and residential areas creates noise, pollution, traffic congestion, road damage, spilled sand along roadways, and numerous other safety and aesthetic concerns (USACE 2001). Use of upland sand source(s) will likely result in greater impacts to county infrastructure. To supply the sand to the beach, the project would daily place 260 or more trucks on the road. This number represents a significant increase in large truck traffic in the project area and roads from the selected sand mine or mines to project area. The City of Ft. Pierce and Florida Department of Transportation recently completed major roadway, landscaping, lighting, and stormwater improvements along Highway A1A, which would provide road access to the proposed staging areas. Impacts associated with increased vehicular traffic may include

- air quality degradation
- increased petroleum products in stormwater runoff from the roads
- increased noise
- greater potential for collision with upland wildlife
- increased traffic congestion
- spilled sand along roadways
- reduced vehicular and pedestrian safety as a result of increased truck traffic

Alternate modes of transportation could ease the problem of delivering sand from mines to the beach. Trains and barges could potentially reduce infrastructure impacts and project completion times. However, none of the local sand mines has rail access, and the project beach likewise is remote from a train station. The barge delivery method involves transfer of sand from truck to barge at a port, and this comes with its own costs and technical difficulties (Taylor Engineering 2009). No project in Florida has yet used either of these alternate modes of transportation for upland mined sand.

Ongoing public education and readily available means of contact with the county to answer questions and resolve project-related issues would help manage public concerns associated with increased truck traffic and other project-related issues to which the public may react.

Use of upland sand would also provide a potential local economic stimulus, assuming that the cost of the project using upland sand (either as partial or total source) provided a more cost-effective project than the sole use of offshore sand. Businesses within the county have clearly indicated during the EIS scoping process and to county officials (personal communication, Richard Bouchard, St. Lucie County, May-June 2010) their belief that use of a local (St. Lucie County) upland sand source would help stimulate the local economy.

The upland sand source alternative is not expected to provide the most cost-effective project and may likely not meet the schedule requirements for completion of work within a single construction season. For these reasons, this alternative did not receive further, detailed evaluation. The proposed offshore sand source will remain the Applicant's preferred alternative sand source. However, allowing contractors to develop bids for the project based on offshore and/or upland sand sources would help identify and select the most cost-effective project.

2.2. ISSUES AND BASIS FOR CHOICE

This DEIS compares formulated beach and dune restoration alternatives to the existing conditions of each characteristic area. **Section 1.6** lists the issues that provide the foundation for this comparison.

2.3. APPLICANT'S PREFERRED ALTERNATIVE

The Applicant's preferred plan, as detailed in **Section 2.1.4**, comprises beach and dune restoration of the 3.8-mile project area from R-87.7 to R-90.3 and R-98 to R-115+1,000 ft (St. Lucie/Martin County line). The project would restore the 1972 dune profile with a 35-ft beach berm extending seaward from the dune toe along the length of the project area.

2.4. ALTERNATIVES ELIMINATED FROM DETAILED EVALUATION

With the exception of the No-Action alternative, all non-structural alternatives were eliminated from detailed evaluation because they did not meet the project goals. All of the structural alternatives, with the exception of beach and dune restoration and T-head groins with sand fill, were also eliminated. The following subsections provide the reasons for eliminating specific alternatives from detailed consideration.

2.4.1. REZONING OF BEACH

In some areas, rezoning of the beach area to restrict or limit future upland construction could effectively reduce the risk of storm damage to upland structures associated with shoreline retreat. In the project area, upland development has already occurred and rezoning the area would not result in any substantial reduction in potential risks to upland property. This alternative fails to achieve the project purpose and needs, and does not warrant detailed evaluation.

2.4.2. CONSTRUCTION MORATORIUM OR NO-GROWTH PROGRAM

Assuming local interests would accept a moratorium on future construction, implementation of such a policy would have little impact on the level of storm risk associated with the current erosion affecting the project area, and would not achieve the project purpose or need relative to the recreational beach or sea turtle nesting habitat. More importantly, a no-growth program would prove ineffective in this area because the majority of the area has already undergone development and the remainder has permanent status as public land. This alternative is currently insufficient to fulfill the project purpose and needs, and for those reasons does not warrant further detailed evaluation.

2.4.3. EVACUATION PLANNING

Similar to other extra-jurisdictional alternatives, improved evacuation could potentially reduce the loss of life during severe storms. Appropriate state and local emergency management officials may pursue such planning. However, this alternative does not address the project purpose and needs, and for those reasons will not receive detailed evaluation.

2.4.4. CONDEMNATION OF LAND STRUCTURES

Local governments have the power, under certain conditions of public interest, to condemn land or structures. In limited circumstances, public agencies can also justify removal of condemned structures. Assuming the application of such a policy in the upland areas adjacent to the project area, a public agency could remove all upland structures. In that case, the condemnation alternative would allow the shoreline to erode naturally. This alternative may prove acceptable along undeveloped shorelines, but remains inappropriate in this case because of extensive upland development and the likelihood that at this time, no public agency would receive the legal authority for such an action. For this reason, the alternative did not receive detailed evaluation.

2.4.5. RELOCATION OR RETROFIT STRUCTURES

Appropriate retrofit and/or relocation of structures to provide flood-proofing could protect infrastructure. Flood-proofing and/or moving existing structures would likely necessitate complete cooperation by private entities and failing that, some condemnation of the land and structures in highly developed areas such as the project beach. As discussed above, condemnation is unlikely to prove feasible. No cost-effective means exists to move many of the structures in the affected area. This alternative would do nothing to alleviate beach erosion, which would result in the loss of valuable wildlife habitat and recreational beach. This alternative would not fulfill the project purpose and need. Therefore, this alternative did not receive detailed evaluation.

2.4.6. MODIFICATION OF BUILDING CODES

Existing Florida building codes include structural requirements intended to minimize potential impacts to the beach-dune system and reduce building damage in severe storms. In the extensively developed project area, many of the structures do not conform to current building standards. These non-conforming buildings are generally exempt from existing codes unless substantially modified. Modification of the building codes could reduce storm risks associated with the current condition of the shoreline; however, modification fails to address the principal project purpose to protect upland development and the secondary purposes to restore the recreational beach and create sea turtle nesting habitat. Therefore, this alternative did not receive detailed evaluation.

2.4.7. CONSTRUCTION SETBACK LINE

A construction setback line would not affect existing development and could only become effective in the unforeseeable future as new buildings replace those razed or destroyed by storms. Florida has established construction control lines along the shores of coastal counties. Based on this line, a construction permit program controls development along Florida's coastline. Like the modification of building codes, this alternative is insufficient to achieve the project purpose and need. Thus, the alternative did not receive detailed evaluation.

2.4.8. REVETMENT

Revetments typically prevent erosion landward of the revetment. However, they most often result in an increased beach slope and decreased beach width as waves carry sediment off the beach. Alternatively, revetments could act as wide groins and capture sand, causing erosion to downdrift beaches. Construction of a revetment would not likely serve secondary project purposes and needs with respect to maintenance of a recreational beach or restoration of sea turtle nesting habitat. Consequently, this alternative did not receive detailed evaluation.

2.4.9. SEAWALLS

Seawalls would provide a significant degree of upland storm damage protection. However, wave energy reflecting off seawalls and bulkheads often has resulted in steepening of the beach profile and consequent loss of beach width. Seawalls may create hazardous bathing conditions due to minimal beach area, increased undertow currents, and run outs (rapidly flowing current running from the beach out to sea). Construction of seawalls would likely result in loss of the sea turtle nesting habitat and recreational beach. Seawalls would present an increased hazard for bathers and others in the water. These seawall effects would result in substantial environmental impact and economic loss to the area. Seawalls would not serve the project purpose and needs. Consequently, this alternative did not receive detailed evaluation.

2.4.10. NEARSHORE BERM

This alternative entails placing material dredged from an adjacent inlet or offshore borrow area into the nearshore ocean adjacent to the beach, typically in less than about 30 ft of water. Recent improvements in dredging technology allow construction of nearshore berms in water depths of <15 ft. In some areas, construction of a nearshore berm can help reduce beach erosion and provide a measure of storm protection to upland property. However, a berm would not restore the width of the beach (the primary storm protection aspect of the beach and basis of recreational opportunities) or restore turtle nesting habitat. Construction of a nearshore berm could result in direct impacts to hardbottom resources, likely in this case due to extensive hardbottom exposure over much of the nearshore bottom area. In addition, berm erosion through time could result in indirect impacts to downdrift hardbottom habitat.

This alternative did not receive detailed evaluation because it failed to satisfy the project purpose and needs. This alternative provides insufficient storm protection for upland properties, does not restore the recreational beach or create sea turtle nesting habitat, and may likely result in more extensive impacts to nearshore hardbottom than those of the proposed project.

2.4.11. BREAKWATERS

The USACE provides this general description of breakwaters:

> *Breakwaters are generally shore-parallel structures that reduce the amount of wave energy reaching the protected area. They are similar to natural bars, reefs, or nearshore islands and are designed to dissipate wave energy. The reduction in wave energy slows the littoral drift, produces sediment deposition and a shoreline bulge or "salient" feature in the sheltered area behind the breakwater. Some longshore sediment transport may continue along the coast behind the nearshore breakwater.* (http://chl.erdc.usace.army.mil/chl.aspx?p=s&a=ARTICLES;187)

Breakwaters entail placement of hard materials (rocks or prefabricated structures, usually concrete) to reduce beach incident wave energy and thus reduce cross-shore erosion by sediment capture in the lee of the structure. Submerged breakwaters may function similarly to a nearshore berm (**Section 2.4.10**) but provide a more permanent structure. PEP (prefabricated erosion prevention) reefs and submerged artificial reefs comprise particular material forms of a submerged breakwater. Emergent breakwaters extend above the water surface.

Emergent or submerged offshore breakwaters — structures placed parallel to the shoreline — act to dissipate incoming wave energy and can reduce the potential for both longshore and cross-shore sediment transport in their lee. Submerged breakwaters do not greatly degrade recreation or aesthetic aspects of the beach, but dissipate less incoming wave energy than an emergent breakwater. Compared to submerged structures of similar size, emergent breakwaters dissipate more incoming wave energy but can induce greater negative impacts to recreation — through more extreme changes to local current patterns and to beach aesthetics. The lower crest elevation of a submerged breakwater requires less material and results in a smaller structure footprint on the seafloor. In addition, some groups have suggested that the presence of breakwaters (emergent or submerged, depending on maximum elevation) can reduce beach access to nesting turtles, impede ocean access for recently hatched turtles, and cause increased predation.

The complex interaction of waves, water levels, and currents near breakwaters adjacent to the beach causes difficulty predicting breakwater effects on sediment dynamics and shoreline responses. Difficulties relate to the appropriate distance of the breakwater from the shoreline, the best size of the breakwater gaps (spacing between adjacent breakwaters), and the effective prediction of the relationship between incident wave conditions and the corresponding level of shore protection. In addition, questions arise regarding how much sand these structures will accumulate from adjacent beaches owing to the interruption of longshore sediment transport or diffraction around the breakwaters and whether they will bypass some sand or act as a complete littoral barrier. Typically, engineers design nearshore breakwaters to maintain existing shoreline positions or to induce modest shoreline advancement. The presence of breakwaters does not increase the sediment supply to the project area. Therefore, any shoreline advancement (gain in volume) must result in erosion (volume loss) at another location.

A PEP (prefabricated erosion prevention) reef is an alternative entailing the placement of prefabricated (usually concrete) structures intended to reduce incident wave energy, allowing accretion of sediment in the lee of the structure. Such reefs have had minimal success reducing beach erosion in Florida. In May 1988, Willis DuPont installed approximately 552 ft of PEP reef at the DuPont Property between R-114 and R-116 in the Town of Palm Beach. Based on more than two years of monitoring data, these structures proved ineffective in reducing shoreline erosion; the state ordered the PEP reef removed (Stauble and Tabar 2003). In December 1991, the Town of Palm Beach received authorization to construct 4,000 ft of experimental PEP reef in the mid-town beach area. In August 1992, the town installed 57 structural units, some 684 ft in length along the approximate 9-ft depth contour. The town installed the remainder of the reef by August 1993. Three years of monitoring data demonstrated that the PEP reef exacerbated erosion. The Town of Palm Beach elected to voluntarily remove the PEP reef and use the materials for groin construction (Martin and Smith 1997; Stauble and Tabar 2003). In 1995, Indian River County constructed a PEP reef in Vero Beach. Subsequent monitoring data indicated that the PEP reef had not significantly affected (improved or impacted) the adjacent beach (FDEP 2008).

Experimental PEP reefs previously installed along the southeast Florida coastline at locations near the proposed project have failed to prevent shoreline erosion or restore the recreational beach and sea turtle nesting habitat.

Specific to the St. Lucie County South Beach and Dune Restoration Project area, offshore breakwaters with beach fill, though maintenance of the design project shoreline, could serve to meet the project goals to increase storm protection, restore important coastal habitat for wildlife, and maintain recreational capacity of the beach. However, this conjecture assumes that the constructed breakwater system performs as predicted; the large uncertainty associated with performance within littoral systems may result in over or under capture of sand. In addition to the difficulty of accurately predicting breakwater performance within a littoral system, the breakwaters could cause erosion to adjacent downdrift locations, negatively impact recreational activity on the beach, and result in coverage of nearshore ephemeral hardbottom. For these reasons, in particular the uncertainty in breakwater performance in this setting, the breakwaters with beach fill alternative fails to achieve the project purpose and needs and does not warrant detailed evaluation.

2.4.12. BREAKWATERS WITH DUNE AND BEACH FILL

Construction of breakwaters with an associated beach fill will increase the sediment supply in downdrift beaches and advance the beach width with the structures acting to modify incoming wave energy. However, in an area that features nearshore ephemeral hardbottom (such as the nearshore of the proposed project area), construction of offshore breakwaters (submerged or emergent) could cause impacts to the hardbottom that require mitigation. The cost to determine appropriate mitigation sites and to construct the required mitigation may offset the benefit accrued by the structures (e.g., reduced sediment transport and erosion leeward of the structures).

A series of segmented breakwaters constructed along the beach might reduce sand losses and retain sand placed in the project area. As with groins, the potential benefit of breakwaters in addition to beach fill focuses on longer retention of the beach fill.

The breakwater conceptual design (provided by the Applicant and considered here) is similar to a design currently under review by FDEP (FDEP Permit Application No. 0267233-001-JC). Note that the design presented here provides only a means to evaluate “typical” breakwater design, and is not intended to suggest or propose specific design criteria. The combination of a breakwater field with a dune and beach template alternative would not alter the fill template design or required volume. For the level of detail considered in this analysis, changes in the breakwater design (e.g., emergent or submerged breakwater) would not greatly alter the effects (impacts or benefits) offered by the structures.

For this analysis, each breakwater would have the following characteristics:

- Offshore Distance (from MHWL) – 225 ft
- Crest Length (shore parallel) – 255 ft
- Crest Width (shore normal) – 15 ft
- Crest Elevation – +2.0 ft NAVD
- Seaward slope (from crest to seaward toe) – 3H:1V
- Landward slope (from crest to landward toe) – 2H:1V
- Alongshore spacing between breakwaters – 200 ft

Using the Applicant’s preferred alternative as an example, the breakwaters with dune and beach fill alternative would impact about 1.18 acres of hardbottom (personal communication, Lois Edwards, Coastal Tech, October 2010).

Each breakwater would cost an estimated $493,000. The proposed project area could require up to 36 breakwaters at a total initial cost of $17.7M. Added to the cost of dune and beach fill ($8.85M), the alternative would cost about $26.5M (excluding mitigation). Impacts and required mitigation for those impacts would increase from those estimated for the 35-ft berm alternative without providing additional benefits.

Breakwaters reduce littoral drift and trap sand or prevent erosion, causing accretion or reduced erosion in the lee of each breakwater and along the updrift shoreline. However, these structures concurrently increase erosion of the downdrift beach by preventing an equivalent volume of sand from moving into the downdrift beach. As with groins, breakwaters may retain sand in the project area during storms, but an equivalent volume of sand will erode from downdrift beaches.

FDEP rules and policies require mitigation for the effects of breakwaters in the form of fill placement on the downdrift beaches to offset the sand trapped by the breakwaters. Breakwaters would not decrease beach nourishment volume requirements, as any volume of trapped sand will erode the downdrift beaches and require mitigation via placement of an equivalent volume of sand on the downdrift beach — in this case, the Martin County Shore Protection Project.

Due to the uncertainty of an expected net positive benefit for this alternative, the level of impacts likely associated with this alternative, and the significantly increased costs associated with the alternative, breakwaters with dune and beach fill did not receive detailed evaluation.

2.4.13. GROIN FIELD WITHOUT BEACH NOURISHMENT

The USACE provides this general description of groins:

> *Groins are the oldest and most common shore-connected, beach stabilization structure. They are structures that extend, fingerlike, perpendicularly or nearly right angles from the shore and are relatively short when compared to navigation jetties at tidal inlets. Usually constructed in groups called groin fields, their primary purpose is to trap and retain sand, nourishing the beach compartments between them. A series of groins along the project beach (a groin field) might reduce sand losses and retain sand placed in the project area*. (http://chl.erdc.usace.army.mil/chl.aspx?p=s&a=ARTICLES;188&g=41)

Under some conditions, groins and other sand trapping structures installed in the absence of beach nourishment can trap longshore sediment transport; the sediment trapped can help restore a beach. Installation of a multiple-groin system (a groin field) typically provides a more favorable shoreline response than a single-groin alternative because the shoreline exhibits a more uniform beach fill response to a groin field than to a single groin. The creation or maintenance of a beach creates, maintains, or increases turtle nesting habitat. These structures typically provide hard substrate that develops biological productivity similar in some ways to that occurring on natural nearshore hardbottom substrate.

Installation of a groin field without beach nourishment likely would trap sand sufficient to restore the recreational beach partially and to create some additional turtle nesting habitat. The volume of sediment subsequently eroded from downdrift beaches would equal or exceed volume of trapped sediment by the groin or groin system.. In addition, the placement of groins would likely incur several environmental impacts. The groin footprint would decrease the beachfront area for turtle nesting and could increase dangers to hatchling turtles moving into the ocean. The groin would cover more hardbottom than alternatives without a groin and create dangers to swimmers from the presence of the structures. Given the level of impacts to natural resources likely associated with this alternative and the likelihood that a groin system would transfer erosion to the downdrift beach rather than not solve the problem, the installation of groins in the absence of beach fill did not receive detailed evaluation.

2.5. COMPARISON OF ALTERNATIVES

Table 2.5-1 lists the alternatives and summarizes the major features and effects of each alternative selected for detailed evaluation. **Section 4 – Environmental Effects** provides a more detailed discussion of the impacts associated with each alternative.

Table 2.5-1. Summary of Direct and Indirect Impacts

ALTERNATIVE ENVIRONMENTAL FACTOR	Beach Fill to Restore 1972 Dune with 35-ft Berm (Preferred)	Beach Fill with No Impact to Existing Hardbottom	Beach Fill to Restore the 1972 Beach and Dune	Beach Fill to Restore the 1972 Dune with 70-ft berm	South Segment Beach and Dune Restoration; North Segment Dune Restoration Only	Beach and Dune Restoration with T-Head Groins	No-Action Status Quo
PROTECTED SPECIES	Sea turtle nesting area increased; potential for incidental "take" of sea turtles; potential encounters with sea turtles, manatees, and North Atlantic right whales during dredging. Burial of 1.08 acres of nearshore hardbottom habitat used as foraging habitat by juvenile sea turtles.	Sea turtle nesting area increased; potential for incidental "take" of sea turtles; potential encounters with sea turtles, manatees, and North Atlantic right whales during dredging.	Sea turtle nesting area increased; potential for incidental "take" of sea turtles; potential encounters with sea turtles, manatees, and North Atlantic right whales during dredging. Fill equilibrium may buy 0.14 acre of nearshore hardbottom habitat used as foraging habitat by juvenile sea turtles.	Sea turtle nesting area increased; potential for incidental "take" of sea turtles; potential encounters with sea turtles, manatees, and North Atlantic right whales during dredging. Fill equilibrium may buy 1.34 acres of nearshore hardbottom habitat used as foraging habitat by juvenile sea turtles.	Sea turtle nesting area increased; potential for incidental "take" of sea turtles; potential encounters with sea turtles, manatees, and North Atlantic right whales during dredging. Fill equilibrium may buy 0.07 acres of nearshore hardbottom habitat used as foraging habitat by juvenile sea turtles.	Sea turtle nesting area increased; potential for incidental "take" of sea turtles; potential for increased hatchling predation due to presence of T-head groins; potential encounters with sea turtles, manatees, and North Atlantic right whales during dredging. Fill equilibrium may buy 1.13 acres of nearshore hardbottom habitat used as foraging habitat by juvenile sea turtles.	Sea turtle nesting would continue to decrease as beaches erode; Continued dune erosion may threaten protected dune species.
HARDGROUNDS	Burial of 1.08 acres of nearshore hardbottom habitat; Potential secondary impacts related to temporary increases in turbidity and sedimentation during dredging and beach placement.	Potential secondary impacts related to temporary increases in turbidity and sedimentation during dredging and beach placement.	Burial of 0.14 acre of nearshore hardbottom habitat; Potential secondary impacts related to temporary increases in turbidity and sedimentation during dredging and beach placement.	Burial of 1.34 acres of nearshore hardbottom habitat; Potential secondary impacts related to temporary increases in turbidity and sedimentation during dredging and beach placement.	Burial of 0.07 acres of nearshore hardbottom habitat; Potential secondary impacts related to temporary increases in turbidity and sedimentation during dredging and beach placement.	Burial of 1.13 acres of nearshore hardbottom habitat; Potential secondary impacts related to temporary increases in turbidity and sedimentation during dredging and beach placement.	Additional hard grounds may become exposed.
SHORELINE EROSION	Minimizes erosion losses over the life of the project; maintains a high quality beach for recreation and storm protection.	Minimizes erosion losses over the life of the project; maintains a high quality beach for recreation and storm protection.	Minimizes erosion losses over the life of the project; maintains a high quality beach for recreation and storm protection.	Minimizes erosion losses over the life of the project; maintains a high quality beach for recreation and storm protection.	Minimizes erosion losses over the life of the project; maintains a high quality beach for recreation and storm protection.	Minimizes erosion losses over the life of the project; maintains a high quality beach for recreation and storm protection.	Shoreline would continue to erode at its present rate.

Table 2.5-1. Summary of Direct and Indirect Impacts

ALTERNATIVE ENVIRONMENTAL FACTOR	Beach Fill to Restore 1972 Dune with 35-ft Berm (Preferred)	Beach Fill with No Impact to Existing Hardbottom	Beach Fill to Restore the 1972 Beach and Dune	Beach Fill to Restore the 1972 Dune with 70-ft berm	South Segment Beach and Dune Restoration; North Segment Dune Restoration Only	Beach and Dune Restoration with T-Head Groins	No-Action Status Quo
FISH AND WILDLIFE RESOURCES	Temporary impacts to infaunal populations at the dredging and beach placement sites; potential temporary disturbance to foraging and resting shorebirds during beach placement; burial of 1.08 acres of nearshore hardbottom habitat may cause relocation of motile faunal populations, reductions in fish recruitment and feeding success; and mortality of demersal fish species.	Temporary impacts to infaunal populations at the dredging and beach placement sites; potential temporary disturbance to foraging and resting shorebirds during beach placement.	Temporary impacts to infaunal populations at the dredging and beach placement sites; potential temporary disturbance to foraging and resting shorebirds during beach placement; burial of 0.14 acres of nearshore hardbottom habitat may cause relocation of motile faunal populations, reductions in fish recruitment and feeding success; and mortality of demersal fish species.	Temporary impacts to infaunal populations at the dredging and beach placement sites; potential temporary disturbance to foraging and resting shorebirds during beach placement; burial of 1.34 acres of nearshore hardbottom habitat may cause relocation of motile faunal populations, reductions in fish recruitment and feeding success; and mortality of demersal fish species.	Temporary impacts to infaunal populations at the dredging and beach placement sites; potential temporary disturbance to foraging and resting shorebirds during beach placement; burial of 0.07 acres of nearshore hardbottom habitat may cause relocation of motile faunal populations, reductions in fish recruitment and feeding success; and mortality of demersal fish species.	Temporary impacts to infaunal populations at the dredging and beach placement sites; potential temporary disturbance to foraging and resting shorebirds during beach placement; burial of 1.13 acres of nearshore hardbottom habitat may cause relocation of motile faunal populations, reductions in fish recruitment and feeding success; and mortality of demersal fish species.	Continued erosion would decrease habitat for faunal populations that use beach and dune habitats.
VEGETATION	Temporary impact during dune and beach fill placement; Increase in plant density where planting occurs; Increased protection of dune vegetation during storms due to wider beach	Temporary impact during dune and beach fill placement; Increase in plant density where planting occurs; Increased protection of dune vegetation during storms due to wider beach	Temporary impact during dune and beach fill placement; Increase in plant density where planting occurs; Increased protection of dune vegetation during storms due to wider beach	Temporary impact during dune and beach fill placement; Increase in plant density where planting occurs; Increased protection of dune vegetation during storms due to wider beach	Temporary impact during dune and beach fill placement; Increase in plant density where planting occurs; Increased protection of dune vegetation during storms due to wider beach	Temporary impact during dune and beach fill placement; Increase in plant density where planting occurs; Increased protection of dune vegetation during storms due to wider beach	Continued erosion could further impact dune vegetation.
WATER QUALITY	Temporary, localized increase in turbidity at the dredging and beach placement sites. The contractor will monitor turbidity during project construction to meet water quality permit conditions.	Temporary, localized increase in turbidity at the dredging and beach placement sites. The contractor will monitor turbidity during project construction to meet water quality permit conditions.	Temporary, localized increase in turbidity at the dredging and beach placement sites. The contractor will monitor turbidity during project construction to meet water quality permit conditions.	Temporary, localized increase in turbidity at the dredging and beach placement sites. The contractor will monitor turbidity during project construction to meet water quality permit conditions.	Temporary, localized increase in turbidity at the dredging and beach placement sites. The contractor will monitor turbidity during project construction to meet water quality permit conditions.	Temporary, localized increase in turbidity at the dredging and beach placement sites. The contractor will monitor turbidity during project construction to meet water quality permit conditions.	No impact.

Table 2.5-1. Summary of Direct and Indirect Impacts

ALTERNATIVE ENVIRONMENTAL FACTOR	Beach Fill to Restore 1972 Dune with 35-ft Berm (Preferred)	Beach Fill with No Impact to Existing Hardbottom	Beach Fill to Restore the 1972 Beach and Dune	Beach Fill to Restore the 1972 Dune with 70-ft berm	South Segment Beach and Dune Restoration; North Segment Dune Restoration Only	Beach and Dune Restoration with T-Head Groins	No-Action Status Quo
HISTORIC PROPERTIES	No impact.	No impact.	No impact.	No impact.	No impact.	No impact.	No impact.
RECREATION	Restored beach and dune will provide increased area for recreational use; temporary disturbance during project construction due to site restriction; increases in turbidity may decrease snorkeling and diving visibility conditions adjacent to the beach placement area; turbidity and dredging disturbance may temporarily affect fishing conditions adjacent to the dredging site.	Restored beach and dune will provide increased area for recreational use; temporary disturbance during project construction due to site restriction; increases in turbidity may decrease snorkeling and diving visibility conditions adjacent to the beach placement area; turbidity and dredging disturbance may temporarily affect fishing conditions adjacent to the dredging site.	Restored beach and dune will provide increased area for recreational use; temporary disturbance during project construction due to site restriction; increases in turbidity may decrease snorkeling and diving visibility conditions adjacent to the beach placement area; turbidity and dredging disturbance may temporarily affect fishing conditions adjacent to the dredging site.	Restored beach and dune will provide increased area for recreational use; temporary disturbance during project construction due to site restriction; increases in turbidity may decrease snorkeling and diving visibility conditions adjacent to the beach placement area; turbidity and dredging disturbance may temporarily affect fishing conditions adjacent to the dredging site.	Restored beach and dune will provide increased area for recreational use; temporary disturbance during project construction due to site restriction; increases in turbidity may decrease snorkeling and diving visibility conditions adjacent to the beach placement area; turbidity and dredging disturbance may temporarily affect fishing conditions adjacent to the dredging site.	Restored beach and dune will provide increased area for recreational use; temporary disturbance during project construction due to site restriction; increases in turbidity may decrease snorkeling and diving visibility conditions adjacent to the beach placement area; turbidity and dredging disturbance may temporarily affect fishing conditions adjacent to the dredging site.	Beaches would continue to erode resulting in decreased beach width for recreation; potential increase in nearshore snorkeling and diving opportunities due to increased hardbottom exposure.
AESTHETICS	Temporary impact associated with presence of dredging and construction equipment; Long-term improvement by providing a wider, more visually-attractive beach.	Temporary impact associated with presence of dredging and construction equipment; Long-term improvement by providing a wider, more visually-attractive beach.	Temporary impact associated with presence of dredging and construction equipment; Long-term improvement by providing a wider, more visually-attractive beach.	Temporary impact associated with presence of dredging and construction equipment; Long-term improvement by providing a wider, more visually-attractive beach.	Temporary impact associated with presence of dredging and construction equipment; Long-term improvement by providing a wider, more visually-attractive beach.	Temporary impact associated with presence of dredging and construction equipment; Long-term improvement by providing a wider, more visually-attractive beach. Presence of T-head groins may detract from visual aesthetics as they become exposed.	Continued erosion would result in degraded aesthetics due to a decrease in beach width and advancement of the surf zone.

Table 2.5-1. Summary of Direct and Indirect Impacts

ALTERNATIVE ENVIRONMENTAL FACTOR	Beach Fill to Restore 1972 Dune with 35-ft Berm (Preferred)	Beach Fill with No Impact to Existing Hardbottom	Beach Fill to Restore the 1972 Beach and Dune	Beach Fill to Restore the 1972 Dune with 70-ft berm	South Segment Beach and Dune Restoration; North Segment Dune Restoration Only	Beach and Dune Restoration with T-Head Groins	No-Action Status Quo
NAVIGATION	Temporary, minor impacts to navigation due to the presence of dredging equipment at borrow site.	Temporary, minor impacts to navigation due to the presence of dredging equipment at borrow site.	Temporary, minor impacts to navigation due to the presence of dredging equipment at borrow site.	Temporary, minor impacts to navigation due to the presence of dredging equipment at borrow site.	Temporary, minor impacts to navigation due to the presence of dredging equipment at borrow site.	Temporary, minor impacts to navigation due to the presence of dredging equipment at borrow site.	No Impact.
ECONOMICS	Short-term impacts to beach-associated tourism revenues during project construction; Short-term impacts to recreational and commercial diving and fishing within the offshore borrow site; Long-term benefits due to storm damage reduction and wider beach for recreation.	Short-term impacts to beach-associated tourism revenues during project construction; Short-term impacts to recreational and commercial diving and fishing within the offshore borrow site; Long-term benefits due to storm damage reduction and wider beach for recreation.	Short-term impacts to beach-associated tourism revenues during project construction; Short-term impacts to recreational and commercial diving and fishing within the offshore borrow site; Long-term benefits due to storm damage reduction and wider beach for recreation.	Short-term impacts to beach-associated tourism revenues during project construction; Short-term impacts to recreational and commercial diving and fishing within the offshore borrow site; Long-term benefits due to storm damage reduction and wider beach for recreation.	Short-term impacts to beach-associated tourism revenues during project construction; Short-term impacts to recreational and commercial diving and fishing within the offshore borrow site; Long-term benefits due to storm damage reduction and wider beach for recreation.	Short-term impacts to beach-associated tourism revenues during project construction; Short-term impacts to recreational and commercial diving and fishing within the offshore borrow site; Long-term benefits due to storm damage reduction and wider beach for recreation.	Adverse effects due to continued erosion of existing beach. Potential loss of tourism revenues due to decreased beach width and recreational opportunities. Increased potential for storm damages including loss of buildings and infrastructure.

Table 2.5-1. Summary of Direct and Indirect Impacts

ALTERNATIVE ENVIRONMENTAL FACTOR	Beach Fill to Restore 1972 Dune with 35-ft Berm (Preferred)	Beach Fill with No Impact to Existing Hardbottom	Beach Fill to Restore the 1972 Beach and Dune	Beach Fill to Restore the 1972 Dune with 70-ft berm	South Segment Beach and Dune Restoration; North Segment Dune Restoration Only	Beach and Dune Restoration with T-Head Groins	No-Action Status Quo
ESSENTIAL FISH HABITAT	Short-term infaunal diversity changes in the nearshore and offshore soft bottom habitats; Burial of acres of nearshore 1.08 hardbottom EFH causing relocation of motile species, mortality of demersal species, reductions in feeding success; Sand removal from offshore shoal could adversely affect EFH for coastal pelagic fishes, dolphin and wahoo, and highly migratory species; Sand mining impacts include elevated turbidity, sedimentation, disruption of feeding activities and migratory routes, and entrainment.	Short-term infaunal diversity changes in the nearshore and offshore soft bottom habitats; Sand removal from offshore shoal could adversely affect EFH for coastal pelagic fishes, dolphin and wahoo, and highly migratory species; Sand mining impacts include elevated turbidity, sedimentation, disruption of feeding activities and migratory routes, and entrainment.	Short-term infaunal diversity changes in the nearshore and offshore soft bottom habitats; Burial of 0.14 acres of nearshore hardbottom EFH causing relocation of motile species, mortality of demersal species, reductions in feeding success; Sand removal from offshore shoal could adversely affect EFH for coastal pelagic fishes, dolphin and wahoo, and highly migratory species; Sand mining impacts include elevated turbidity, sedimentation, disruption of feeding activities and migratory routes, and entrainment.	Short-term infaunal diversity changes in the nearshore and offshore soft bottom habitats; Burial of 1.34 acres of nearshore hardbottom EFH causing relocation of motile species, mortality of demersal species, reductions in feeding success; Sand removal from offshore shoal could adversely affect EFH for coastal pelagic fishes, dolphin and wahoo, and highly migratory species; Sand mining impacts include elevated turbidity, sedimentation, disruption of feeding activities and migratory routes, and entrainment.	Short-term infaunal diversity changes in the nearshore and offshore soft bottom habitats; Burial of 0.07 acres of nearshore hardbottom EFH causing relocation of motile species, mortality of demersal species, reductions in feeding success; Sand removal from offshore shoal could adversely affect EFH for coastal pelagic fishes, dolphin and wahoo, and highly migratory species; Sand mining impacts include elevated turbidity, sedimentation, disruption of feeding activities and migratory routes, and entrainment.	Short-term infaunal diversity changes in the nearshore and offshore soft bottom habitats; Burial of 1.13 acres of nearshore hardbottom EFH causing relocation of motile species, mortality of demersal species, reductions in feeding success; Sand removal from offshore shoal could adversely affect EFH for coastal pelagic fishes, dolphin and wahoo, and highly migratory species; Sand mining impacts include elevated turbidity, sedimentation, disruption of feeding activities and migratory routes, and entrainment.	No Impact.

2.6. MITIGATION AND MONITORING

Any project proposing sand fill to restore the dune would unavoidably impact dune vegetation; alternatives nourishing the beach would, with two exceptions (the No-Action and Beach Fill with No Impact to Hardbottom alternatives), impact nearshore hardbottom habitats. Impacts to dune vegetation and nearshore hardbottom will require mitigation. The Applicant has submitted a Draft Mitigation Plan (**Appendix D**) that describes proposed mitigation for impacts associated with the Applicant's preferred plan.

In addition, the Applicant has proposed physical and biological monitoring to track project performance over a period of years (**Appendix E** and **Appendix F**). The monitoring plans should provide the means to assess project impacts from a physical and biological perspective.

2.6.1. MITIGATION

2.6.1.1. Dune Vegetation

Due to the severe impact of the 2004 hurricanes Frances and Jeanne, St. Lucie County implemented a dune restoration/revegetation project in southern St. Lucie County. Replanted areas included the dune system from R-87.7 to R-90.3 and from R-98 to the St. Lucie/Martin County line (R-115+1000). Plantings included sea oats and other native coastal dune species. The revegetation project covered much of the south segment of the currently proposed project. Plant survival and expansion has demonstrated successful establishment and proliferation of plant species proposed for use in the mitigation project the Applicant proposes.

The project may place fill over vegetation located within the upper beach/pioneer zone of the dune system, but beach fill will not occur landward of the dune crest. The upper beach/pioneer zone typically contains halophytic species that also tolerate xeric conditions; many of these species have high growth rates and spread rapidly as they grow. Typical species found in the upper beach/pioneer zone include railroad vine (*Ipomoea pes-caprae*), seashore paspalum (*Paspalum distichum*), sea purslane (*Sesuvium portulacastrum*), and sea oats (*Uniola paniculata*). Pioneer species trap wind-blown sand, resulting in sand accumulation and eventual establishment of a dune system.

After project construction, the Applicant will plant the restored dune with a mix of native coastal dune pioneer plants, which may include sea oats (*U. paniculata*), beach sunflower (*Helianthus debilis*), railroad vine (*I. pes-caprae*), and dune panic grass (*Panicum amarum*), depending upon nursery availability at the time of planting. Roughly 360,000 planting units will be installed 18 inches on center in staggered rows on the dune crest (**Table 2.6-1)**.

Table 2.6-1. St. Lucie County South Beach and Dune Restoration Project Proposed Dune Plantings

Common Name	Scientific Name	% of Total	Quantity	Size
Sea Oats	*Uniola paniculata*	80	291,200	Liner
Dune Panic Grass	*Panicum amarum*	13	47,320	Liner
Railroad Vine	*Ipomoea pes-caprae*	4	14,560	Liner
Dune Sunflower	*Helianthus debilis*	3	10,920	Liner

2.6.1.2. Nearshore Hardbottom

For each alternative evaluated in detail, the Applicant used aerial photographs (2008) and the estimated project equilibrium toe of fill location to estimate hardbottom impacts. GIS professionals interpreted and quantified the hardbottom areas visible in the photographs and calculated the amount of hardbottom area landward of the equilibrium toe of fill. Based on a field survey, the hardbottom communities were identified as Community One or Community Two (CSA International 2010a).

Hardbottom Community One consists of low- to medium-relief hardbottom with a significant wormrock (*Phragmatopoma lapidosa*) component (approximately 10% coverage along monitoring transects) relatively close to shore. This community supports biota such as hydroids, encrusting sponges, macroalgae, and turf algae (**Figure 2.6-1**). The physical characteristics of this community type facilitate the establishment and proliferation of *P. lapidosa*, while also supporting a large percent cover of robust, canopy-forming red algae. This community type provides shelter and nutrient source to many invertebrate, fish, and turtle species. Additionally, wormrock builds reef and contributes to the biological diversity of the nearshore environment.

Hardbottom Community Two consists of less biologically complex, low relief, consolidated coquina rock ledges. The well-defined, undercut ledges include exposed coquina rock with little or no biotic cover. The habitat mostly provides physical refuge space (CSA International 2010a). This community did not have the wormrock component or robust macroalgae evident in Hardbottom Community One. The Applicant concluded that the Hardbottom Community Two represented hardbottom substrate located in areas subject to the relatively constant physical dynamics of the nearshore environment, specifically sand movement, scouring, and alternating sand burial and subsequent re-exposure (**Figure 2.6-2**).

Figure 2.6-1. Representative photograph of Hardbottom Community One with well-developed worm-rock community (from CSA International 2010a)

Figure 2.6-2. Representative photograph of Hardbottom Community Two (from CSA International 2010a)

Based on fieldwork reported by CSA International (2010a), the Applicant estimated hardbottom impacts by community type for each alternative considered in detail (**Table 2.6-2**). The Applicant's UMAM scores and analyses (except for the impact acres) reported in the Draft Mitigation Plan (**Appendix D**) provided the basis for the calculation of estimated mitigation acres (**Table 2.6-2**).

Table 2.6-2. Estimated Impact and Mitigation Acres for Each Alternative Evaluated in Detail

	Alternatives							
	Hardbottom Community Type	**Beach Fill to Restore 1972 Dune with 35-ft Berm**	**Beach Fill with No Impact to Existing Hardbottom**	**Beach Fill to Restore the 1972 Beach and Dune**	**Beach Fill to Restore the 1972 Dune with 70-ft berm**	**North Segment Dune Restoration Only**	**Beach and Dune Restoration with T-Head Groins**	**No-Action**
Impact Acres	Community 1	0.39	0	0.09	0.55	0	0.44	0
	Community 2	0.69	0	0.05	0.79	0.07	0.69	0
	Total Impact Acres	**1.08**	**0**	**0.14**	**1.34**	**0.07**	**1.13**	**0**
Mitigation Acres	Community 1	0.48	0	0.11	0.68	0	0.54	0
	Community 2	0.50	0	0.05	0.57	0.05	0.50	0
	Total Mitigation Acres	**0.98**	**0**	**0.16**	**1.25**	**0.05**	**1.04**	**0**

To offset unavoidable impacts to nearshore hardbottom, the Applicant has proposed construction of low relief mitigation reefs at several possible locations in the general project area. The Applicant intends to locate the reefs at depths similar to the impacted areas, though "due to the nebulous logistics in constructing artificial structures in depths less than 4m as well as the public safety hazard and reduced probability of success in very nearshore regions, the mitigation reef(s) may be constructed in depths exceeding those at impacted areas." (**Appendix D: Draft Mitigation Plan**).

The following criteria guided selection of potential mitigation locations:

- Veneer of sand over rock substrate (no coverage of exposed or likely exposed hardbottom
- 15m (50 ft) buffer between constructed reef and surrounding hardbottom
- Proximity (approximately one-quarter mile) to county park(s) to facilitate public use
- Water depths between about 3.7 and 4.6m (12 and 15 ft)
- Locations between the two impact sites to facilitate recruitment from the two community types, as well as to house fleeing motile fauna during project construction

The Applicant proposed the use of jet probes to identify appropriate locations for mitigation reef placement (personal communication, Richard Bouchard, St. Lucie County, January 2011).

The Applicant identified a low relief design (**Figure 2.6-3)** to mimic the impacted habitats. However, the Applicant has also indicated that to achieve success, the mitigation efforts may require strategies not yet identified:

> *As identified within the Department-commissioned literature synthesis of hardbottom habitat ecological functions (CSA 2009, page 8-11), "Because of the stability and logistic issues stated above, it is apparent that NHB [nearshore hardbottom] cannot be mitigated for in like-kind fashion, given present technology and budgets." Given all these limitations in constructing acceptable like-kind mitigation, the County intends to remain flexible in developing strategies for success.* (**Appendix D: Draft Mitigation Plan**)

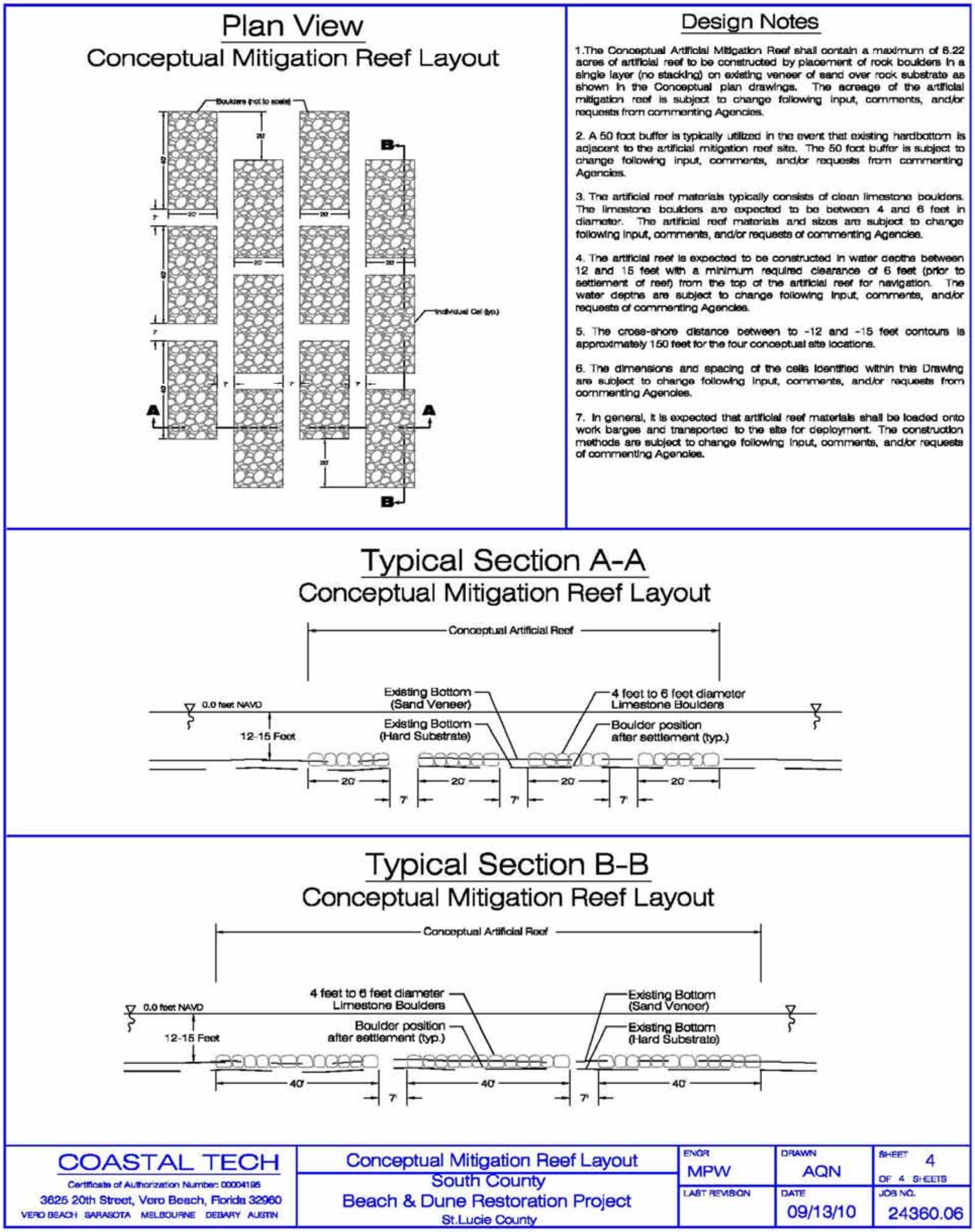


Figure 2.6-3. Conceptual Reef Mitigation Design
(from **Appendix D: Draft Mitigation Plan**)

2.6.2. MONITORING

2.6.2.1 Physical

As detailed in the Draft Physical Monitoring Plan (**Appendix E**), physical monitoring of the St. Lucie County South County Beach and Dune Restoration Project proposes to accomplish the following objectives:

- Identify erosion and accretion patterns (shoreline and volumetric changes) along the project and adjacent shorelines
- Provide data to facilitate an engineering evaluation of the beach nourishment performance based upon pre- and post-construction surveys and subsequent monitoring surveys
- Identify beach segments that have lost sand in quantities that may require corrective actions
- Identify location of the equilibrated toe of fill (ETOF)
- Determine whether the borrow area is experiencing infilling under post-construction conditions.

The primary components of the physical monitoring plan include

- Beach profile and hydrographic surveys of the project area and adjacent beaches
- Hydrographic surveys of the borrow area
- Vertical aerial photography along the limits of the surveyed beach

Surveys conducted before and immediately after construction, and annually for three years, and after five years comprise the proposed physical data collection effort. Timely reports summarizing the data collection and analysis results submitted to the lead state and federal regulatory agencies will demonstrate project permit compliance (or lack thereof). Long-term, these data will provide a basis to track requirements for any further beach nourishment activities.

Annual aerial photography will provide the link between physical conditions and biological conditions at the project site. The FDEP guidance document, *Monitoring Standards for Beach Erosion Control Projects*, will provide the guidance for aerial photography with the following exceptions:

- Part II – Execution, Section B. Flight 16: To provide for best visibility of hardbottom features, St. Lucie County will require that the photographs capture conditions during an incoming tide.
- Part II – Execution, Section B. Flight 17: The photographs will capture the entire project area during one flight rather than during a “schedule” of flights.

St. Lucie County will schedule aerial photography of the beach to occur as closely as possible to the other post-construction surveys and each annual monitoring period.

This task will produce controlled, vertical, color aerial photography along the coastline of St. Lucie County for the primary purpose of mapping and quantifying exposed nearshore hardbottom and natural/artificial reefs. Aerial photography and biological survey work will occur as close together as reasonably possible.

The photographs will allow the Applicant to document consistency between conditions identified along surveyed profile lines and the field delineation of the exposed nearshore hardbottom.

2.6.2.2. Dune Vegetation

Within 30 days of dune planting, monitoring will occur to evaluate initial survival and to ensure the planting followed the plans and specifications. One year following planting completion, the Applicant will monitor the planting areas to determine plant survivorship and overall success. As detailed in **Appendix D**, the Applicant proposes the following activities:

- To assess total areal plant cover at completion of planting, monitoring will occur within 30 days of planting completion. The simple *Flat Vegetative Cover Test Method* will provide the cover estimate approach. Field biologists will establish several representative photo-reference points. Photographs depicting the completed planting will provide a visual record of initial post-construction conditions. The field biologist performing the monitoring will record the number, size, and location of all species planted, as well as the planting dates and any variation to the planting plan
- One year after planting completion, planted area monitoring will use methods consistent with the immediate post-construction monitoring. The field technician will record the number, size, and location of all species planted, and any necessary re-plantings. If any of the planted species are not proliferating, the Applicant will propose other appropriate coastal dune pioneer species. After approval of regulatory agencies, the county will replace the failed plants. If plant mortality occurs due to human encroachment, the Applicant will erect temporary fencing to remain until the planting project meets the success criteria.
- At the end of the one-year post-construction monitoring period, starting from the time the last plant was installed (or replaced at any time after the initial planting), 80% or greater survival of the initial plantings will constitute project planting success and the end of monitoring and maintenance activities. Mortality as a result from loss of dune structure (e.g., slumping due to escarpment formation) will be noted and will not be included in the required planting survivorship. If at the end of the first year, the monitoring data show less than 80% survival, replanting and monitoring shall continue until monitoring demonstrates 80% survivorship of native dune plants over a full year.

2.6.2.3. Nearshore Hardbottom

As detailed in the Draft Biological Monitoring Plan (**Appendix F**) and Draft Mitigation Plan (**Appendix D**), the Applicant proposes a three-year monitoring period for nearshore hardbottom, including the beach nourishment and mitigation areas. Monitoring of nearshore hardbottom will occur immediately post-construction and annually for at least three years post-construction. Monitoring of the post-nourishment beach area will assess impacts (if any) resulting from the project. Mitigation area monitoring will assess level of ecosystem function achieved by the artificial reef.

When an appropriate weather / water clarity window occurs between 1 May and 30 September, personnel will conduct the fieldwork, which includes

- Monitoring and control transect video recording, with video or photographs of example species and hard corals along each transect
- Voucher samples of macroalgae
- In situ quadrat data collection including visual estimate of percent cover and genus/species identifications
- Diver video survey of pipeline corridors used as dredge pipeline routes
- Nearshore hardbottom edge mapping
- Nearshore fish census and sampling

UMAM scoring of the mitigation reef ecosystem will provide the basis for assessing the degree to which the system has achieved ecosystem organization and function comparable to the natural system impacted by the project. The Applicant has also identified its intent to use an adaptive management plan to adjust for unanticipated changes that occur during and after a three-year monitoring period.

2.6.2.4. Sea Turtles

The Applicant will conduct sea turtle monitoring consistent with requirements the U.S. Fish & Wildlife Service (USFWS) and Florida Fish & Wildlife Conservation Commission (FWC). The following monitoring for nesting sea turtles will occur during construction activities, the nesting season immediately post-construction, and three nesting seasons thereafter.

- Daily early morning surveys for sea turtles will be required if any portion of the sand placement construction occurs during the period from March 1 through April 30, or November 1 through November 30.
- Nesting surveys will begin 65 days before construction activities start or by March 1, whichever occurs later.
- Nesting surveys will continue through the end of the project or through September 30, whichever ends earlier.
- Nighttime surveys for leatherback sea turtles will occur from March 1 through April 30 or until completion of the project (whichever ends earlier). Each night in the project area nesting surveys will occur at one-hour intervals from 9 p.m. until

6 a.m. Because leatherbacks require at least 1.5 hours nesting, this schedule will ensure that the surveyor encounters all nesting leatherbacks.

If turtles construct nests in areas where construction activities may impact them, an FWC-authorized agent must relocate eggs per the FWC requirements.

Applicant proposes five in-water turtle monitoring events, including one immediately after construction and four more events at three-month intervals over the first post-construction year. Surveys conducted from a boat equipped with an elevated observation platform and a GPS navigational system will allow constant monitoring of speed and location during each monitoring effort. Surveys conducted only during periods of calm seas will provide the best conditions for viewing turtles.

2.6.2.5. Shorebirds

The Applicant will conduct all shorebird monitoring to comply with FWC requirements identified in the project permit. Shorebird surveys conducted by trained, dedicated individuals with proven shorebird identification skills and avian survey experience will provide accurate assessments. Nesting season surveys will encompass all potential beach-nesting bird habitats within the project area that construction activities may impact. The nesting season surveys will not include portions of the project area with no potential for project-related activity between the date of the current survey and the next survey. Surveys for detecting new nesting activity will occur on a daily basis before movement of equipment, operation of vehicles, or other activities that could potentially disrupt nesting behavior or cause harm to the birds, to their eggs, or to their young. Surveys will also document the presence of any piping plovers, or other federally listed shorebirds, within or adjacent to the fill site.

2.6.2.6. Benthic Infauna

If the permitted project includes use of an offshore borrow area, pre- and post-construction infaunal biomass surveys will provide data necessary to assess changes that occur as a result of dredging at the site. Samples in the dredging area, the refuge area, and a control location outside the dredging area in similar, adjacent, undisturbed area of shoal habitat will provide the data necessary for change assessment. Counts of fauna sorted into five major taxonomic groupings (annelids, crustaceans, mollusks, echinoderms, and miscellaneous) and ashfree dry weight of each group in each sample will provide the basis for assessment of standing stock changes over time.

2.6.2.7. Escarpments and Compaction

Visual surveys for escarpments along the action area will occur

- Immediately after completion of the project
- Before March 1 for three subsequent years if post-construction tilling does not occur before sea turtle nesting season

- Weekly during the three nesting seasons following completion of beach nourishment

The escarpment survey technician will record the number of escarpments and their location relative to FDEP reference monuments during each weekly survey. In addition, the technician will report the total length of the scarps relative to the length of the beach survey (e.g., 50 percent escarpments). Notations on the height of these escarpments will include ranges (0 to 2 ft, 2 to 4 ft, and 4 ft or higher) as well as the maximum height of all escarpments. If scarp exceeds permit standards for scarps, the Applicant will immediately consult with FWC and FDEP to determine the appropriate action.

Immediately after completion of project construction (April 30) and before March 1 for three subsequent years, the Applicant will either till the beach to improve sand density or monitor sand compaction in the area of sand placement in accordance with a protocol agreed upon by USFWS, USACE, and the county. Monitoring at 500-ft intervals along the project area will test sand density at multiple depths at each sampling location. If the applicant monitors and finds areas of excessive density, the Applicant will till the affected area. Additional penetrometer testing will demonstrate that the tilled area was sufficient to eliminate excessive sand compaction.

2.6.2.8. Beachfront Lighting

Following standard techniques, lighting surveys conducted in accordance with the St. Lucie County lighting ordinance, U.S. Fish & Wildlife Service Biological Opinion, and JCP specific permit conditions will document all artificial lighting visible from the nourished beach. The Applicant will take all appropriate steps under the lighting ordinance to resolve any inappropriate lighting conditions.

2.6.2.9. Monitoring Schedule

The overall monitoring schedule, summarized in **Tables 2.6-3** and **2.6-4**, shows the temporal extent of physical and biological monitoring.

Table 2.6-3. Physical Monitoring Schedule

Activity	Pre-construction	During Construction	Post-construction				
			Immediate	Year 1	Year 2	Year 3	Year 5
Beach and Offshore Profiles	X		X	X	X	X	X
Aerial Photography			X	X	X	X	X
Bathymetric Surveys of Borrow Area	X		X			X	
Sand sampling		X		X	X		
Monitoring Reports			X	X	X	X	X

Sand sampling will occur during construction as part of quality assurance and quality control activities. Two additional annual sampling efforts will verify that the long-term distribution of sand size and qualities remains appropriate.

Table 2.6-4. Biological Monitoring Schedule

Monitoring Activity	Pre-Construction	During Construction	Post-construction			
			Immediate	Year 1	Year 2	Year 3
Dune Vegetation			X	X		
Nearshore Hardbottom, Fish Census	Completed		X	X	X	X
In-Water Turtles	Required		X	X		
Turtle Nesting	Ongoing	X	X	X	X	X
Shorebirds		X	X			
Offshore Benthic Infauna	Required		X	X	X	X
Compaction			X	X	X	X
Escarpment			X	X	X	X
Lighting	Required		X			

3. AFFECTED ENVIRONMENT

3.1. GENERAL ENVIRONMENTAL SETTING

The project area is located along the shoreline of Hutchinson Island, an Atlantic Ocean barrier island, on the southernmost five miles of St. Lucie County beaches (**Figure 1.3-1**). The St. Lucie County Atlantic shoreline is composed of barrier islands separated from the mainland by tidal wetlands, the Indian River Lagoon, land bays, all linked by the Atlantic Intracoastal Waterway (ICW). The barrier island, with elevations ranging from 5 to 25 ft above mean sea level, varies in width from less than 200 ft to more about a mile. This combination results in a tendency for hurricanes to overwash some areas, particularly the lowest areas along narrower portions of Hutchinson Island. Ft. Pierce Inlet at the north end of the Hutchinson Island and St. Lucie Inlet at the south end of the island provide pathways for physical, chemical, and biological exchanges between the Atlantic Ocean, Indian River Lagoon, and the mainland of the Florida peninsula.

The general project area comprises primarily condominium complexes, multifamily and single family homes, and hotels with interspersed public lands and public parks providing access to the Atlantic Ocean beaches. A significant portion of the shoreline and island lie within Coastal Barrier Resources System (CBRS) Unit P-11, a federal designation that prohibits the use of federal funds in those areas, with the intent to afford protection against development to significant sections of remaining natural barrier island resources. The Florida Power and Light Nuclear Power Plant, the major industrial facility on the island, lies less than two miles north of the project area.

Beaches lining the eastern (Atlantic Ocean) side of the island are composed of mineral sands and shell fragments. Coquina rock outcroppings also occur periodically along the shoreline and in the nearshore waters. Mangroves and residential development dominate the western (lagoon) shoreline of the island, and some areas, particularly those narrowest and most prone to complete overwash, are hardened to resist storm erosion.

Storm tides, waves, winds, and currents comprise the major factors driving coastal processes along the St. Lucie County shoreline.

3.1.1. REGIONAL GEOGRAPHIC SETTING AND CLIMATE

The project area is located along the Atlantic Ocean on Hutchinson Island in St. Lucie County, Florida. Hutchinson Island, bounded on the west by the Indian River Lagoon, enjoys a subtropical climate with project area temperatures and winds modulated by the water bodies. St. Lucie County has long, hot summers including regular convection storm and infrequent hurricane rains and winds with temperatures averaging between 80 and 90 degrees. Short mild winters include drier conditions and temperatures typically range between 60 and 70 degrees, rarely dropping to freezing (http://www.visitstluciefla.com/weather.html).

3.1.2. PHYSICAL CONDITIONS

The project area covers the Florida Atlantic coast in the southern region of St. Lucie County, from FDEP reference monuments R-87.7 to R-90.3 and from R-98 to R-115+1,000 ft (St. Lucie/Martin County line) (**Figure 1.3-1**). The project area comprises the Atlantic Ocean shoreline on a barrier island of Florida, and a borrow area located approximately three miles offshore of the project beach. The south St. Lucie County project area will not likely experience a significant amount of further development. Zoning maps for the project area show 83% of the shoreline zoned multifamily, 14% of the shoreline zoned conservation, and 3% zoned commercial. A few vacant zoned for development occur. Notably, the general project area includes no shoreline armoring structures such as seawalls or groins.

The following documents provided as part of the JCP application offer detailed discussion on the physical characteristics of the project area:

- St. Lucie County South County Beach and Dune Restoration Project Revised Design Document (Coastal Tech 2009, 2010b)
- Conditions Assessment Report (Coastal Tech 2009: Attachment P)
- Analysis, Modeling, and Impact Assessment (Coastal Tech 2009: Design Document, Appendix B; Coastal Tech 2010b: Design Document, Appendix B)

3.1.3. WAVES

Waves, primarily driven by local winds, provide an important sediment transport mechanism along the open coast of the project area. Analyses of hindcast wave data along the southeast Florida coast indicate seasonal effects on the wave climate. On average, higher wave heights occur during the winter months — storm season — and smaller wave heights occur during the summer months. Waves of greater height and period rarely occur, except during high storm activity. The majority of waves higher than 1.5 ft arrive from the northeast and east-northeast (**Figure 3.1-1**).

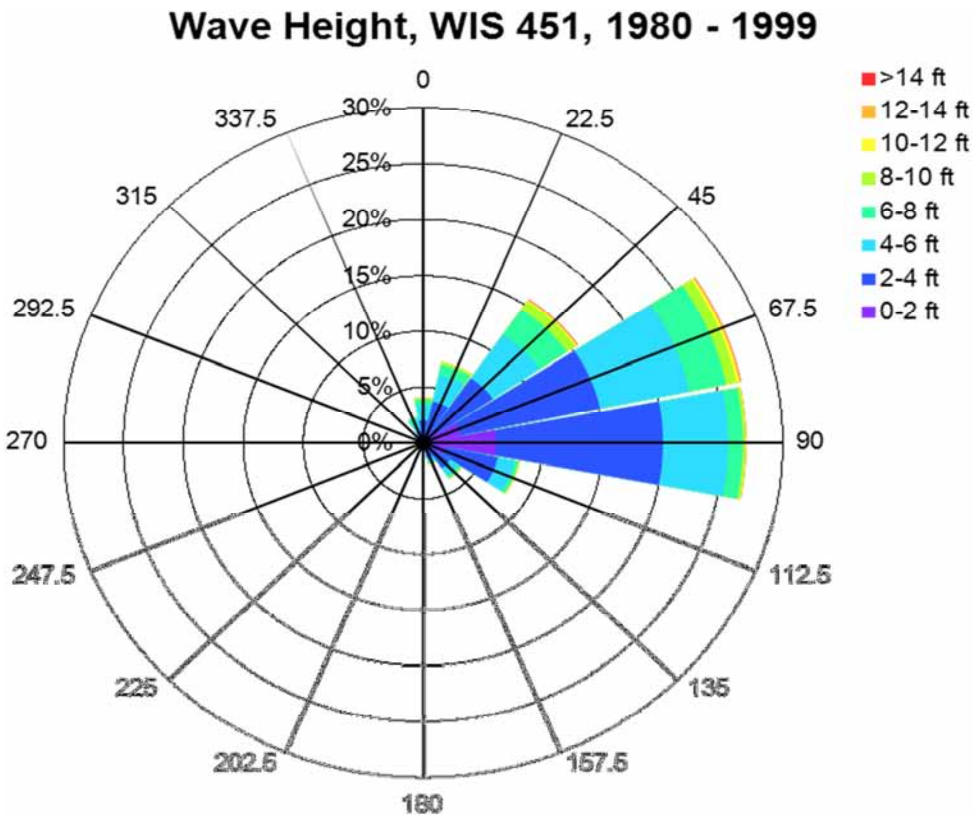


Figure 3.1-1. Wave Height Rose of WIS Station 451 (1980 – 1999)

3.1.4. WINDS

Winds directly transport sand onto the dry beach. They also generate waves, which transport sand on both the dry and wet beach. Characterizing a coastal site typically requires wind measurements on the beach because inland- and offshore-based wind measurements generally prove poor indicators of nearshore wind conditions. In the absence of wind data at the project site, the wind climate station at inland Vero Beach Municipal Airport (station KVRB) provided the data used to characterize local wind conditions. The KVRB wind data showed that winds in the general project area likely originate mostly from the east and southeast, and reach speeds from 10 – 20 mph about 34% of the time (**Figure 3.1-2**).

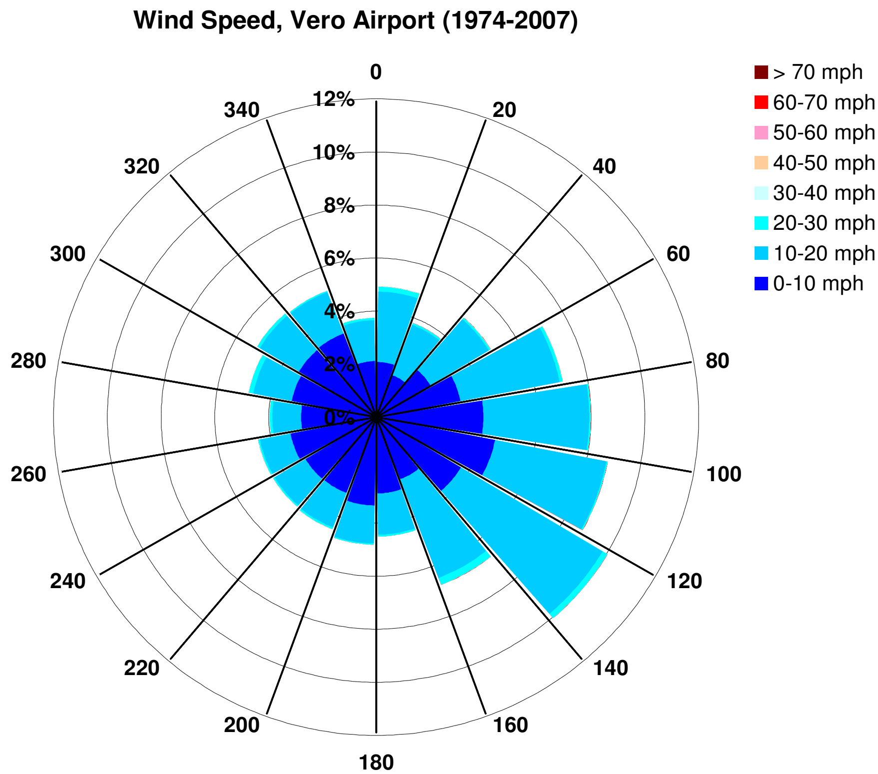


Figure 3.1-2. Wind Speed Rose at Station KVRB from 1974 – 2007

3.1.5. STORMS

Although tropical storms (i.e., tropical depressions, tropical storms, and hurricanes) generally move rapidly through an area, they can devastate a beach. Large wave heights, above-average water levels (i.e., storm surge), and high winds associated with hurricanes and tropical storms can cause significant erosion of the beach and dunes. On average, tropical storms or hurricanes pass near the study area about twice every three years. The most recent severe storms events occurred during the 2004 and 2005 hurricane seasons. In August and September 2004, four hurricanes affected the project area: Frances and Jeanne passed through the project area; Charley passed through Florida west of the project area; and Ivan passed west (of the Florida peninsula and project area) then east of the project area in the Atlantic Ocean. These hurricanes caused different extents of beach and dune erosion.

3.1.6. NATURAL PROCESSES

Aligned northwest-southeast, several beach morphologic regimes occur along the 3.8-mile project shoreline: some areas (R-80 to R-90.3; R-98 to R-115 +1000) have experienced critical erosion, while the other areas have reached a near-equilibrium or accretive state (FDEP 2007). Coastal Tech (2009: Attachment P: Conditions

Assessment Report) evaluated the historical shoreline — mean high water (MHW) location of +0.4ft NAVD — and volume changes for the Study Area (R-77 to R-115) from February 1972 to September 2008. The Coastal Tech analysis showed that from 1972 to 2008

- A general erosion trend occurred throughout most of the Study Area.
- From R-77 to R-102, the beaches generally eroded and the shoreline generally retreated.
- The greatest volumetric losses and shoreline retreat occurred between R-90 and R-100.
- From R-103 to R-109, beaches slightly accreted and advanced slightly seaward.
- The significant amount of erosion and shoreline retreat between R-90 and R-100 corresponds to a change in shoreline orientation and a slight “embayment.”

3.1.7. SEA LEVEL RISE

Taylor Engineering modeled sea level rise in accordance with USACE Circular No. 1165-2-211 (USACE 2009). Circular No. 1165-2-211 specifies the use of three sea level rise rates for all civil works program — “low,” “intermediate,” and “high.” Best determined from tide gauges, low rates reflect the historic rate of sea-level change. The nearest NOS tide stations to the project area with sufficient historical data to measure sea level rise lie at Mayport and Daytona Beach north and Miami Beach south of the study area. The Mayport station showed an average sea level rise of 2.40 mm/yr with high confidence. The Daytona Beach station showed a rise of 2.32 mm/yr with lower confidence. The Miami Beach station showed a rise of 2.39 mm/yr with high confidence. Therefore, this analysis used data from Mayport and Miami Beach to estimate sea level rise for the St. Lucie County project area.

NOAA (http://www.co-ops.nos.noaa.gov) publishes mean sea level (MSL) trends for the Atlantic coast of Florida. Based on data (1928 – 1999) from Station 8720220 Mayport and data (1931 – 1981) from Station 8723170 Miami Beach, MSL rises 0.238 m and 0.244 m (0.80 and 0.78 ft) *per century*. These rates correspond to 2.38 and 2.44 mm per year. Adjusting the rate for the project location with respect to the location of the two tide gauges provided a project area low (baseline) total local sea level rise of 155 mm over a 50-year period.

Gross sea level rise includes changes in land elevation, which vary around the globe. At this time, research located no local land elevation change data. In 2007, the Intergovernmental Panel on Climate Change (IPCC) published a global mean sea level rise of 1.7 ± 0.5 mm/yr in the twentieth century. In the absence of definitive local data, this analysis estimated a vertical land movement of -0.7 mm/yr in St. Lucie County (2.4 mm/yr – 1.7 mm/yr).

Estimates of intermediate and high rates employed the modified NRC-I and NRC-II curves (USACE 2009) to predict a sea level rise of 0.5 m and 1.5 m over 114 years

(1986 to 2100). These data applied in the following equation (from USACE 2009) yielded the intermediate and high sea level rise rates in the project area:

$$E(t) = 0.0017t + bt^2$$

Where $E(t)$ is the amount of eustatic sea-level rise since 1986 in meters, t is the time in years since 1986, and b is a constant. Taylor Engineering formulated this equation to eliminate the constant b given that $E(t)$ is known when $t = 114$ (in 2100).

$$E(t_2) = (t_1/t_2) * [0.0017*t_1*(t_1-t_2) + \mathrm{E}(t_1)*t_2]$$

Where t_1 always equals 114 years, and $E(t_1)$ equals 0.5 m for scenario NRC-I and 1.5 m for NRC-III. The analysis period begins in 2011 ($t_2 = 25$ years) and ends in 2061 ($t_2 = 75$ years).

Table 3.1-1 presents the results of the sea level rise calculation. The low rate represents the historic rate of sea level rise. The 2011 Sea Level and 2061 Sea Level come from the calculations above; the Average Sea Level Rise equals the difference between these two levels divided by 50 years. The Total Local Sea Level Rise incorporates the estimated vertical land movement (0.7 mm/yr).

Table 3.1-1. Estimated Sea Level Rise, Project Area in South St. Lucie County, FL

Rate	Average Sea Level Rise m/yr (ft/yr)	Total Local Sea Level Rise m/yr (ft/yr)	50-yr Total Local Sea Level Rise m (ft)
Low	0.0024 (0.0078)	0.0009 (0.0031)	0.0472 (0.1550)
Intermediate	0.0041 (0.0132)	0.0014 (0.0048)	0.0725 (0.2378)
High	0.0118 (0.0382)	0.0038 (0.0123)	0.1897 (0.6225)

3.1.8. SEDIMENT CHARACTERISTICS

Tables 3.1-2 and **3.1-3** present the available native beach and offshore sediment characteristics as reported by the Minerals Management Service (MMS 1995, 1999, 2002) (recently changed to the Bureau of Ocean Energy Management, Regulation and Enforcement [BOEM]), Coastal Planning and Engineering (CP&E 2006), Coastal Tech (2009: Appendix D: Geotechnical Analyses), and Taylor Engineering (2010).

Table 3.1-2. Native Beach Sediment Characteristics

Source	Location	Mean Grain Size (mm)	% Fines	% Carbonate	Sorting
MMS (1995, 1999, 2002)	R-3, R-25, R-33, R-38, R-47, R-66, R-76, R-93, R-111	0.62	N/A	60	N/A
CP&E (2006)	R-93, R-96	0.42	0.82	N/A	Poorly Sorted
Coastal Tech (2009)	R-77, R-80, R-85, R-90, R-95, R-98, R-100, R-105, R-110, R-115	0.46	0.19	53	Moderately Sorted
Taylor Engineering (2010)	Beach Composite	0.53	0.14	49.31	N/A

Table 3.1-3. Offshore Sediment Characteristics

Source	Location	Mean Grain Size (mm)	% Fines	% Carbonates	Sorting
MMS (2002)	St. Lucie Shoal, Development	0.40	1.98	87.5	0.89
	St. Lucie Shoal, Reconnaissance	0.43	1.652	85.4	0.902
CP&E (2006)	Pierce Shoal	0.43	2.99	N/A	1.26
	BA 1	0.39	3.14	N/A	1.21
	BA 2	0.47	2.43	N/A	1.23
	BA 3	0.42	3.25	N/A	1.33
	BA 4	0.43	2.27	N/A	1.30
	BA 5	0.44	1.97	N/A	1.09
Coastal Tech (1995, 1996)	Capron Shoal	0.42	1.73	N/A	1.03
	Shoal AB	0.53	1.20	N/A	1.22
	Shoal D	0.40	3.20	N/A	1.48
	Shoal E	0.39	1.50	N/A	0.79
	Shoal F	0.39	2.20	N/A	0.84

3.1.9. HARDBOTTOM

Nearshore sediments comprise marine sand. These sands are underlain by limestone outcrops of the Anastasia formation, which exhibits significant elevation differences over short spatial scales. Thus, exposure of the formation, termed “hardbottom,” in the nearshore environment occurs variably along the barrier island system in southeast Florida. Hardbottom, common in the project area, sometimes occurs in the surf zone but more frequently lies 300 ft – 1000 ft from the beach. Sand intermittently exposes or buries the hardbottom areas located in the surf zone and within the limits of the depth of closure (-17 ft NAVD) depending on the elevation of the hardbottom and wave conditions (Coastal Tech 2010a). Digitization of the hardbottom signature seen in August 1, 2008 aerial photographs (see Figures 6a – 6c in the Coastal Tech 2009: Design Document) provided the set of hardbottom maps used in this EIS .

3.2. VEGETATION

Vegetation consisting of beach morning glory (*Ipomoea imperati*), railroad vine (*Ipomoea pes-capre*), sea grapes (*Coccoloba uvifera*), sea oats (*Uniola paniculata*), sea purslane (*Sesuvium sp.*), and beach elder (*Iva imbricata*) typically dominate the dune area. Due to the severe impact of Hurricanes Frances and Jeanne in 2004, the county implemented a dune restoration/revegetation project in southern St. Lucie County (Coastal Tech 2009: Design Document). The dune system from R-98 to R-101.4 and from R-103.3 to the St. Lucie/Martin County line was revegetated primarily with sea oats with occasional railroad vine, sea grapes, and sea purslane interspersed.

3.3. THREATENED AND ENDANGERED SPECIES

The project area lies within the coastal area of St. Lucie County, Florida. The U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) have identified the threatened and endangered species listed **Table 3.3-1** as potentially occurring in St. Lucie County. Of the species listed in **Table 3.3-1**, the five species of sea turtles, manatee, humpback and right whales, smalltooth sawfish, and piping plover are most likely to occur within the project vicinity.

The Biological Assessment (BA) (**Appendix G**) discusses threatened and endangered species in detail, identifies potential project impacts on the species, and provides protection and conservation recommendations. The BA fulfills USACE requirements under Section 7(c) of the Endangered Species Act of 1973 (ESA).

Table 3.3-1. Federally Listed Threatened and Endangered Species that May Occur in St. Lucie County, Florida

Common Name	Scientific Name	Listing Status	
		USFWS	NMFS
PLANTS			
Fragrant prickly-apple	*Cereus eriophorus var. fragrans*	Endangered	-
Lakela's mint	*Dicerandra immaculata*	Endangered	-
Tiny polygala	*Polygala smallii*	Endangered	-
BIRDS			
Audubon's crested caracara	*Polyborus plancus audubonii*	Threatened	-
Everglade snail kite	*Rostrhamus sociabilis plumbeus*	Endangered	-
Florida scrub-jay	*Aphelocoma coerulescens*	Threatened	-
Kirtland's Warbler	*Dendroica kirtlandii*	Endangered	-
Piping plover	*Charadrius melodus*	Threatened	-
Red-cockaded woodpecker	*Picoides borealis*	Endangered	-
Wood stork	*Mycteria americana*	Endangered	-
MAMMALS			
Florida panther	*Puma concolor coryi*	Endangered	
Southeastern beach mouse	*Peromyscus polionotus niveiventris*	Threatened	
West Indian manatee	*Trichechus manatus*	Endangered	
Blue whale	*Balaenoptera musculus*	-	Endangered
Finback whale	*Balaenoptera physalus*	-	Endangered
Humpback whale	*Megaptera novaeangliae*	-	Endangered
Sei whale	*Balaenoptera borealis*	-	Endangered
Sperm whale	*Physeter macrocephalus*	-	Endangered
North Atlantic right whale	*Eubalaena glacialis*	-	Endangered
REPTILES			
American alligator	*Alligator mississippiensis*	Threatened/SA[1]	-
American crocodile	*Crocodylus acutus*	Threatened	-
Eastern indigo snake	*Drymarchon corais couperi*	Threatened	-
Green sea turtle	*Chelonia mydas*	Endangered	Endangered
Hawksbill sea turtle	*Eretmochelys imbricata*	Endangered	Endangered
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered	Endangered
Leatherback sea turtle	*Dermochelys coriacea*	Endangered	Endangered
Loggerhead sea turtle	*Caretta caretta*	Threatened	Threatened
FISH			
Smalltooth sawfish	*Pristis pectinata*	-	Endangered

[1] SA = Similarity of Appearance to a listed taxon
Sources: (USFWS website: http://ecos.fws.gov/tess_public/countySearch!speciesByCountyReport.action?fips=12111 accessed December 2010 and NOAA/NMFS website: http://sero.nmfs.noaa.gov/pr/endangered%20species/specieslist/PDF2010/Florida%20Atlantic.pdf accessed December 2010)

3.3.1. SEA TURTLES

St. Lucie County is within the normal nesting areas of three species of sea turtles: loggerhead sea turtle (*Caretta caretta*), green sea turtle (*Chelonia mydas*), and leatherback sea turtle (*Dermochelys coriacea*). The loggerhead is listed as a threatened species, while all other sea turtles are listed as endangered under the U.S. Endangered Species Act of 1973. In St. Lucie County, the Florida Fish and Wildlife Conservation Commission defines March 1 through October 31 as the official nesting season for all species of sea turtles.

3.3.1.1. Nesting Habitat

Turtle nesting occurs in south St. Lucie County within the project area. Loggerhead, green, and leatherback turtles currently account for all nests in the project area (EAI 2007, 2008, 2009a).

Between 2000 and 2009, approximately 91.2% of the total sea turtle nests in the project area were loggerheads, followed by 7% green sea turtle nests, and 1.8 % leatherback sea turtle nests. During the six previous nesting seasons (2004 through 2009), project area nests totaled 1366, 1447, 1433, 1535, 1794, and 1626 (personal communication, Jonathan Gorham, Inwater Research Group; May 2010; personal communication,Beth Brost, FWC, July 2010).

The project area lies within two Statewide Nesting Beach Survey (SNBS) zones: North Hutchison Island (24.5 km) in St Lucie County and South Hutchison Island (12 km) in Martin County. FWRI (2008) reported the following nesting activity on North Hutchinson Island between 1993 and 2007:

- 68,602 loggerhead turtles (an average of 4,573 per nesting season)
- 2,478 green sea turtles (an average of 165 per nesting season)
- 964 leatherback turtles (an average of 64 per nesting season)

FRWI (2008) also reported the following nesting activity on the beaches of south Hutchinson Island, Martin County between 1993 and 2007:

- 26,152 loggerhead turtles (an average of 1,743 per nesting season)
- 812 green sea turtles (an average of 54 per nesting season)
- 898 leatherback turtles (an average of 60 per nesting season)

The Index Nesting Beach Survey (INBS) coordinates a detailed monitoring program in conjunction with SNBS. The State of Florida established this program to measure seasonal productivity, allowing comparisons between beaches and between years. Within the project area, this program divides the Atlantic beaches of Florida into 1 km zones with a separate letter designation for each zone. The project renourishment area includes INBS zones q through y. INBS zones P and Z comprise beach adjacent to nearshore mixing zone waters. **Table 3.3-2** summarizes the loggerhead sea turtle nests documented by INBS zone / FDEP reference monuments between 2000 and 2009.

Table 3.3-2. Loggerhead Sea Turtle Nests by INBS Zone in the Project Area (2000 – 2009)

LOGGERHEAD (Caretta caretta)

INBS Zone	R - Monument	Nests									
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
P	R-84 - R-87.5	267	232	184	155	138	178	116	185	154	122
Q	R-87.5 - R-91	371	270	216	200	218	337	213	212	240	193
R	R-91 - R-94.5	288	190	212	196	205	259	123	150	171	157
S	R-94.5 - R-98	470	390	351	289	241	408	168	162	320	255
T	R-98 - R-101	342	356	287	248	214	270	245	261	356	360
U	R-101 - R-104	344	346	371	292	249	184	155	162	243	215
V	R-104 - R-108	344	376	301	273	193	197	230	146	236	267
W	R-108 - R-111	274	217	246	212	197	68	213	195	259	185
X	R-111 - R-114.5	274	196	169	188	136	65	172	149	140	143
Y	R-114.5 - R-3.5	253	213	217	177	95	162	116	112	139	132
Z	R-3.5 - R-7	184	89	136	111	79	107	93	78	129	80
	Totals	**3411**	**2875**	**2690**	**2341**	**1965**	**2235**	**1844**	**1812**	**2387**	**2109**

Data Sources: INSB Zones P – S: personal communication, Jonathan Gorham, Inwater Research Group, Inc. May 6, 2010. INSB Zones T – Z personal communication, Beth Brost, Florida Fish and Wildlife Commission Index Nesting Beach Survey Database July 1, 2010. Note: Zones P – S are year totals, while Zones T – Z include data between May 15 and August 31.

Table 3.3-3 summarizes the Green sea turtle nests documented by INBS zone / FDEP reference monument between 2000 and 2009.

Table 3.3-3. Green Sea Turtle Nests by INBS Zone in the Project Area (2000 – 2009)

GREEN TURTLE (Chelonia mydas)

INBS Zone	R - Monument	Nests									
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
P	R-84 - R-87.5	20	0	4	8	8	18	3	8	9	1
Q	R-87.5 - R-91	15	0	5	10	1	21	9	12	7	11
R	R-91 - R-94.5	16	1	13	8	5	38	11	26	14	8
S	R-94.5 - R-98	25	0	45	8	6	74	29	44	14	13
T	R-98 - R-101	52	2	42	8	13	40	31	89	74	40
U	R-101 - R-104	62	10	86	13	10	51	18	51	32	16
V	R-104 - R-108	23	1	47	4	15	15	7	24	15	10
W	R-108 - R-111	17	1	31	11	4	11	3	49	14	8
X	R-111 - R-114.5	22	0	18	3	3	3	6	19	4	7
Y	R-114.5 - R-3.5	20	1	10	2	4	11	2	12	6	0
Z	R-3.5 - R-7	11	0	6	0	1	5	2	6	3	3
	Totals	**283**	**16**	**307**	**75**	**70**	**287**	**121**	**340**	**192**	**117**

Data Sources: INSB Zones P – S: personal communication, Jonathan Gorham, Inwater Research Group, May 6, 2010. INSB Zones T – Z: Beth Brost, Florida Fish and Wildlife Commission Index Nesting Beach Survey Database July 1, 2010. Note: Data for zones Zones P – S reflect annual totals, while data for Zones T – Z reflect totals between May 15 and August 31.

Table 3.3-4 summarizes the Leatherback sea turtle nests documented by INBS zone / FDEP reference monument between 2000 and 2009.

Table 3.3-4. Leatherback Sea Turtle Nests by INBS Zone in the Project Area (2000 – 2009)

LEATHERBACK (Dermochelys coriacea)

INBS Zone	R - Monument	Nests									
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
P	R-84 - R-87.5	2	1	1	1	0	2	0	3	0	0
Q	R-87.5 - R-91	2	0	2	2	1	1	0	4	1	2
R	R-91 - R-94.5	1	5	1	5	3	3	2	3	2	16
S	R-94.5 - R-98	5	13	10	15	10	19	4	16	7	32
T	R-98 - R-101	1	3	2	0	1	2	4	3	3	8
U	R-101 - R-104	0	3	6	3	2	2	1	7	9	3
V	R-104 - R-108	0	5	0	4	4	0	0	0	2	5
W	R-108 - R-111	0	5	3	5	4	1	3	6	6	7
X	R-111 - R-114.5	0	0	2	3	0	0	1	14	4	8
Y	R-114.5 - R-3.5	1	8	3	4	2	6	4	8	4	6
Z	R-3.5 - R-7	1	2	2	2	0	8	3	16	7	13
	Totals	**13**	**45**	**32**	**44**	**27**	**44**	**22**	**80**	**45**	**100**

Data Sources: INSB Zones P – S: personal communication, Jonathan Gorham, Inwater Research Group, Inc. May 6, 2010. INSB Zones T – Z: Beth Brost, Florida Fish and Wildlife Commission Index Nesting Beach Survey Database, July 1, 2010. Note: Data for zones Zones P – S reflect annual totals, while data for Zones T – Z reflect totals between May 15 and August 31.

The data show that in the project area

- Loggerhead turtle nests varied between approximately 1,812 in 2007 and 3,411 nests in 2000, with a 10-year average of 2367 nests;
- Green turtle nests varied between approximately 16 in 2001 and 340 nests in 2007, with a 10-year average of 181 nests; and
- Leatherback turtle nests varied between approximately 13 in 2000 and 100 nests in 2009, with a 10-year average of 45 nests.

3.3.1.2. Inner Shelf Habitat

Five sea turtle species occur on the eastern Florida inner shelf (shoreline to the 20-meter isobath). In order of abundance, based on results of sea turtle monitoring conducted in the project area, these species are the loggerhead, green, hawksbill, Kemp's ridley, and leatherback turtles (**Table 3.3-5**). The table orders the several species from highest to lowest abundance.

Table 3.3-5. Sea Turtle Species Potentially occurring on the Eastern Florida Inner Shelf (Adapted from: NMFS and USFWS, 1991a,b; 1992a,b; 1993; EAI, 2007, 2008, 2009a)

Common and Scientific Names	Status[1]	Life Stages Present	Abundance Within the Project Area	Seasonal Presence	Nesting Season
Loggerhead turtle (*Caretta caretta*)	T	Adults, subadults, juveniles, and hatchlings	Abundant	Year-round (most abundant during spring and fall migrations)	April to September
Green turtle (*Chelonia mydas*)	T/E[2]	Adults, subadults, juveniles, and hatchlings	Common	Year-round	July to August
Leatherback turtle (*Dermochelys coriacea*)	E	Adults, subadults, juveniles, and hatchlings	Rare	March to October	March to July
Hawksbill turtle (*Eretmochelys imbricata*)	E	Adults, subadults, juveniles, and hatchlings	Rare	Year-round	June to September
Kemp's ridley turtle (*Lepidochelys kempi*)	E	Juveniles and subadults	Rare	Year-round (most abundant during spring and fall migrations)	(no nesting in area)

[1] Status: E = endangered, T = threatened under the Endangered Species Act of 1973.
[2] USFWS lists green turtles as threatened except in Florida where breeding populations are listed as endangered. Due to inability to distinguish between the two populations away from the nesting beach, all green turtles occurring in U.S. waters are considered endangered (NMFS and USFWS, 1991a,b)..

The ESA protects all sea turtles in U.S. territorial waters. Currently, the USFWS lists leatherbacks as endangered and loggerheads as threatened. Except for the Florida breeding population, listed as endangered, USFWS also lists green turtles as threatened.

<u>Loggerhead Turtle</u>

Loggerhead turtles (*Caretta caretta*) are present year-round in Florida waters, with peak abundance occurring during spring and fall migrations. Data suggest that nesting adult females are short-term residents that migrate into east Florida waters at 2 to 3-year intervals and reside elsewhere during non-nesting years (Henwood 1987; Schroeder and Thompson 1987). Adult males do not seem to migrate with adult females but may reside in the vicinity of nesting beaches throughout the year. Following nesting activities, many adult loggerheads disperse to the seas around islands in the Caribbean Sea, waters off southern Florida, and the Gulf of Mexico (Meylan and Bjorndal 1983; Nelson 1988). Subadult loggerheads forage opportunistically along the Atlantic seaboard, although evidence suggests that a resident population of subadults overwinter in the Canaveral area each year (Henwood 1987). In Brevard, Indian River, and St. Lucie Counties, juvenile and subadult loggerheads occur throughout the year in estuarine habitats (Ehrhart 1983, 1992; Henwood 1987; Ehrhart and Redfoot 1996; Bresette et al. 2000; Ehrhart et al. 2001; Holloway-Adkins 2005; Provancha et al. 2005).

Juvenile loggerheads, which researchers believe overwinter along the eastern Florida inner shelf, depart in the spring (March – April) when adult males that migrate into the area to mate (Ryder et al. 1994) replace them. The adult loggerhead population (males and females) in Florida waters increases during the nesting season (Magnuson et al. 1990). In general, the eastern coast of Florida appears to provide an important year-round habitat for loggerhead sea turtles along both the inner shelf (0 to 20 meters) and middle shelf (20 to 40 meters) depths. The nearshore rock resources in these areas appear to represent a travel corridor (to nesting sites) rather than a main foraging or developmental habitat (Ryder et al. 1994). Juvenile loggerhead turtles generally feed on insects and invertebrates from within *Sargassum* mats (not present in the project area), while subadult and adult loggerheads primarily feed on bottom dwelling invertebrates (crabs, mollusks, shrimp) and macroalgae (Ryder et al. 1994).

On project beaches, hatchling turtles normally emerge between July and September during the night and swim offshore to begin a pelagic existence within *Sargassum* rafts, drifting in current gyres and convergence zones for several years (Carr 1987; Marine Turtle Expert Working Group 1996a; Witherington 2002). Post-hatchlings from the Florida coast eventually enter currents of the North Atlantic Gyre. At a carapace length of approximately 40 to 60 centimeters, they leave the pelagic environment and move into nearshore habitats (Carr 1987; Bowen et al. 1993).

<u>Green Turtle</u>

The USFWS considers the green turtle (*Chelonia mydas*) as common within the inner shelf waters off the project area. All life stages of green turtles occur during different times of the year in and around the project area. Ecological Associates, Inc. [EAI], (2009a, b,c,d,e,f,g) consistently observed all life stages adjacent to the southern portion of the project area during all seasons, with the most observations in June. Juvenile green turtles (approximately 2 to 5 years of age) also may move into shallow coastal and estuarine waters along the entire east coast of Florida (CSA International 2009a; Schmid 1995; Hirth 1997).

Florida comprises the major feeding grounds for green turtles in U.S. waters, where the turtles forage mainly on algae and the seagrass *Thalassia testudinum* (Burke et al. 1992). The nearshore waters of the project area include no seagrass (CSA International 2010a).

Subadult green turtle habitats on the east coast of Florida include shallow estuarine environments such as the Indian River Lagoon (Ehrhart et al. 1996; Provancha et al. 1998; Bresette et al. 2000), deeper coral and limestone reefs in South Florida (Wershoven and Wershoven 1992; Makowski et al. 2002; Makowski 2004), and shallow nearshore habitats in Brevard, Indian River, and St. Lucie counties (Bresette et al. 1998; Ehrhart et al. 2001; Holloway-Adkins et al. 2002). Subadults also inhabit manmade environments such as shipping channels and turning basins (Henwood 1987; Redfoot 1997).

Several researchers have found juvenile green turtles over nearshore hardbottom habitats in the project area foraging on species of red algae (Ehrhart et al., 1996; Holloway-Adkins, 2001; Holloway Adkins, 2005). The most frequently-consumed species were *Gelidium* spp., *Bryothamnion seaforthii*, *Hypnea* spp., *Gracilaria* spp., *Laurencia* spp., and *Bryocladia cuspidata*. The same reports also described juvenile green turtle consumption of a variety of small invertebrates and occasional portions of jellyfish. However, the overall results indicate juvenile green turtles in nearshore hardbottom habitats feed as herbivores (Holloway-Adkins, 2001; Gilbert, 2005; Holloway-Adkins and Provancha; 2005). Sand, pieces of rock, and shell debris found in foraging samples indicate green turtles forage close to the substrate and, either incidentally or selectively, ingest these non-nutritional items for unknown reasons. Stranding events and foraging studies indicate that sea turtles at all life stages are susceptible to ingesting anthropogenic debris (Balazs, 1985; Carr, 1987; Witherington, 2002).

<u>Leatherback Turtle</u>

Adult leatherback (*Dermochelys coriacea*) turtles reportedly occur in east Florida waters primarily during summer; aerial surveys also have sighted leatherback turtles off northeast Florida from October through April (Schroeder and Thompson 1987, Knowlton and Weigle 1989, Continental Shelf Associates 2002). During these surveys, leatherbacks occurred on the mid-shelf and inner shelf but not usually near shore (Continental Shelf Associates, 2002). However, historical data suggest that leatherbacks also may use inner shelf waters during periods of local thermal fronts that concentrate food resources (Thompson and Huang 1993). The cryptic behavior of hatchling and/or juvenile leatherback turtles has resulted in little knowledge of their pelagic distribution. Leatherback turtles occur very rarely in the nearshore waters of the project area.

<u>Hawksbill Turtle</u>

Hawksbill turtles (*Eretmochelys imbricata)* occur in tropical and subtropical seas of the Atlantic, Pacific, and Indian oceans. In the western Atlantic, hawksbill turtles generally inhabit clear tropical waters near coral reefs, including the southeast Florida coast, Florida Keys, the Bahamas, Caribbean Sea, and southwestern Gulf of Mexico (NMFS and USFWS 1993).

Pelagic hatchling hawksbills drift with *Sargassum* rafts. Available data suggest they are herbivorous during this period but become more omnivorous as they age (Ernst et al. 1994). Juveniles shift to a benthic foraging existence in shallow waters, progressively moving to deep waters as they grow and become capable of deeper dives for sponges (Meylan 1988, Ernst et al. 1994). Adult hawksbills typically associate with coral reefs and similar hardbottom areas where they forage on invertebrates, primarily sponges. No nesting or boat survey performed during 2006, 2007, and 2008 observed any hawksbill nests or animals in the project area (EAI 2007, 2008, 2009a,b,c,d,e,f,g).

Kemp's ridley Turtle

The Kemp's ridley (*Lepidochelys kempi*) is the smallest and most endangered of the sea turtles. Its distribution includes the Gulf of Mexico and southeast U.S. coast, although some individuals have ventured as far north along the eastern seaboard as Nova Scotia and Newfoundland (Marine Turtle Expert Working Group, 1996b). Adult Kemp's ridley turtles occur almost exclusively in the Gulf of Mexico, primarily on the inner shelf (Byles 1988). Kemp's ridley hatchlings inhabit offshore *Sargassum* mats and drift lines associated with convergences, eddies, and rings. Gulf and Atlantic surface currents widely disperse the hatchlings. After reaching a size of about 20 to 60 centimeters carapace length, juveniles enter shallow coastal waters (Marine Turtle Expert Working Group 2000).

Post-pelagic (juvenile, subadult, and adult) Kemp's ridley turtles feed primarily on portunid crabs, but also occasionally eat mollusks, shrimp, dead fishes, and vegetation (Mortimer 1982, Lutcavage and Musick 1985, Shaver 1991, NMFS and USFWS 1992a, Burke et al. 1993, Werner and Landry 1994). The Kemp's ridley is considered very rare in nearshore waters of the project area. No nesting or boat survey performed during 2006, 2007, and 2008 observed any Kemp's ridley nests or animals in the project area (EAI 2007, 2008, 2009a,b,c,d,e,f,g).

3.3.2. MARINE MAMMALS

Three federally-listed species of marine mammals occur on the inner shelf (shoreline to the 20-meter isobath) of the project area (**Table 3.3-6**). The table orders the several species by relative abundance (highest to lowest).

Table 3.3-6. Endangered Marine Mammal Species Potentially Occurring on the Eastern Florida Inner Shelf (Wiley et al. 1995, USFWS 2001, http://www.neaq.org)

Common and Scientific Names	Status[1]	Life Stages Present	Abundance within the Project Area	Seasonal Presence
Florida manatee (*Trichechus manatus latirostris*)	E	Adults, subadults, and juveniles	Common	Year-round (most abundant during winter)
Humpback whale (*Megaptera novaeangliae*)	E	Adults, subadults, and juveniles	Rare	December to March
North Atlantic right whale (*Eubalaena glacialis*)	E	Adults, subadults, and juveniles	Rare	December to March

[1] Status: E = endangered.

3.3.2.1. Florida Manatee

The West Indian manatee is one of the most endangered marine mammals in coastal waters of the U.S. In the southeastern U.S., manatees are limited primarily to Florida and Georgia. This group constitutes a separate subspecies called the Florida manatee (*Trichechus manatus latirostris*) that comprises four recognized populations or management stocks (Atlantic Coast, Southwest, Upper St. John's River, and Northwest), based on regional manatee wintering sites (http://www. nefsc.noaa.gov/nefsc/publications/tm/tm213/F2009App6.pdf; USFWS, 2001). Adult Florida manatees average about 3.0 m (9.8 ft) in length and 1,000 kg (2,200 lbs.) in weight. Their maximum lifespan is approximately 59 years. Age of first pregnancy is 3 to 4 years, and their gestation period for a single calf is 11 to 14 months, with an average interbirth interval of 2.5 years (USFWS 2001).

Manatees are seen mostly as solitary individuals or in groups of up to six individuals. Some larger aggregations may occur, such as feeding groups that may number up to approximately 20 individuals and winter aggregations near sources of warm water (such as power plant outfalls) that may contain hundreds of individuals (Jefferson et al. 2008).

Most manatees in the southeastern U.S. migrate between a summer range and a winter range, determined by water temperature changes. During winter months, the Florida manatee population confines itself to coastal waters of the southern half of peninsular Florida and to springs and warm water outfalls as far north as southeastern Georgia (USFWS 2001). As water temperatures rise in spring, individuals disperse from these winter aggregation areas, some migrating as far north as coastal Virginia (USFWS 2001). Manatees inhabit both salt and fresh water of sufficient depth (1.5 meters to usually less than 6 meters) throughout their range. They are usually found in canals, rivers, estuarine habitats, and saltwater bays, but on occasion have swum as far as 3.7 miles off the Florida coast (USFWS 2001). Within St. Lucie County, manatees are most frequently observed in the Indian River Lagoon and other inland waters. However, they have also been observed along the coast in the shallow, nearshore waters, though only rarely. Individual and small groups of manatees are regularly sighted within shallow nearshore waters off St. Lucie County, including the Ft. Pierce Inlet (personal. communication, Lois Edwards, Coastal Tech, and Keith Spring, CSA International, August 2010) and may graze on the algae present on the intermittent nearshore exposed hardbottom present in the project area.

In 1976, the USFWS designated critical habitat for this species. All of the critical habitat areas are located in peninsular Florida, predominantly along the inland waters of the southwest and southeast coasts (USFWS 2001). However, the project area is not designated as critical habitat.

3.3.2.2. Humpback Whale

The humpback whale (*Megaptera novaeangliae*), federally listed as endangered, is a large baleen whale with a maximum length of about 52 feet (16 meters). Humpback whales range from the Arctic to the West Indies. During summer, at least five geographically distinct feeding aggregations occur in the northern Atlantic (Blaylock et al., 1995). During fall, humpbacks migrate south to the Caribbean where calving and breeding occurs from January to March (Blaylock et al. 1995). Aerial surveys during the Cetacean and Turtle Assessment Program (CETAP) detected only a few humpback whale sightings from New Jersey southward during any season (Winn 1982). However, subsequently there have been numerous sightings and strandings off themid-Atlantic and southeastern U.S. coast, particularly during winter and spring (Swingle et al. 1993, Wiley et al. 1995). Most of the stranded animals were juveniles, suggesting that the area may provide an important developmental habitat (Wiley et al., 1995). Humpbacks feed largely on euphausiids and small fishes such as herring, capelin, and sand lance, and Blaylock et al. (1995) correlated their distribution largely to prey species and abundance. Calving and breeding occurs in the Caribbean from January to March (Tove 2000).

The humpback whale is rarely sighted within the vicinity of St. Lucie County during its spring/fall migration.

3.3.2.3. North Atlantic Right Whale

The North Atlantic right whale (*Eubalaena glacialis*) is one of the most endangered whales in the world. The New England Aquarium's Atlantic right whale research and conservation initiative estimates a total world population of about only 400 (New England Aquarium 2010). North Atlantic right whales range from Iceland to eastern Florida, primarily in coastal waters. This species uses the waters around Cape Cod and Great South Channel to feed, nurse, and mate during summer (Kraus et al. 1988, Schaeff et al. 1993). From June to September, most animals feed north of Cape Cod. Southward migration occurs offshore from mid-October to early January (Kraus et al. 1993). Coastal waters of the southeastern U.S. (off Georgia and northeastern Florida) are important wintering and calving grounds for North Atlantic right whales. Migration northward along the North Carolina coast may begin as early as January but primarily occurs during March and April (Lee and Socci 1989, Minerals Management Service [MMS] 1990).

Designated critical habitat for the North Atlantic right whale includes portions of Cape Cod Bay and Stellwagen Bank and the Great South Channel (off Massachusetts) and a strip of near coastal waters extending from southern Georgia to Sebastian Inlet, Florida; therefore, the project area lies south of the critical right whale habitat . The southern critical habitat area widens near the Georgia-Florida boundary where the highest concentrations of individual whales gather during their winter calving season (typically December through March, with peak calving in December and January). During this time, the population consists primarily of mothers and newborn calves, some juveniles, and occasionally some adult males and noncalving adult females (http://www.neaq.org). Sightings of North Atlantic right whales within waters off Florida are limited to late fall to early spring months. Sightings are concentrated near northeastern Florida and southeastern Georgia; however, sightings of individual whales have been reported as far south as Palm Beach County, Florida.

3.3.3. SMALLTOOTH SAWFISH

The smalltooth sawfish (*Pristis pectinata*), currently listed as endangered by NMFS, rarely occurs within the project area. This species has become rare along the southeastern Atlantic and northern Gulf of Mexico coasts of the U.S. during the past 30 years, with its known primary range now reduced to the coastal waters of Everglades National Park in extreme southern Florida. Fishing and habitat degradation have extirpated the smalltooth sawfish from much of this former range.

The smalltooth sawfish, distributed in tropical and subtropical waters worldwide, normally inhabits shallow waters (10 m or less), often near river mouths or in estuarine lagoons over sandy or muddy substrates, but may also occur in deeper waters (20 m) of the continental shelf. Shallow water less than 1 m deep appears an important nursery area for young smalltooth sawfish. Maintenance and protection of habitat is an important component of the smalltooth sawfish recovery plan (NMFS, 2006). Recent studies indicate that key habitat features (particularly for immature individuals) nominally consist of shallow water, proximity to mangroves, and estuarine conditions. Smalltooth sawfish grow slowly and mature at about 10 years of age. Females bear live young, and the litters reportedly range from 15 to 20 embryos requiring a year of gestation (NMFS 2006). Their diet consists of macroinvertebrates and fishes such as herrings and mullets. The smalltooth sawfish reportedly uses its saw to rake surficial sediments in search of crustaceans and benthic fishes or to slash through schools of herrings and mullets (NMFS 2006).

3.3.4. PIPING PLOVER

The piping plover *(Charadrius melodus)* is a rare to uncommon winter resident that can occur along both the Gulf and Atlantic coasts between September and April. Although found on both coasts, they are more common along the Gulf of Mexico. The piping plover is listed as endangered in Canada and the inland United States, and is threatened along the coast. This small shorebird can occur inland but prefers sandy beaches and tidal mudflats where it forages along the waterline or high up the beach along the wrack line. Piping plovers eat a variety of insects and aquatic invertebrates. Declines have resulted from direct and unintentional harassment by people, dogs, and vehicles; destruction of beach habitat for development; and changes in water level regulation (Haig 1992).

A winter census stated that approximately 20 – 30 piping plovers occur along the Atlantic coast from Duval County south to Brevard, St. Lucie, and Miami-Dade Counties (Florida Natural Areas Inventory [FNAI] 2001). EAI conducted a piping plover survey in the vicinity of the project area (St. Lucie Inlet) from January to May 2009 by in support of permitting planned dune restoration project at Bathtub Beach Park on Hutchinson Island. According to Robert Ernest, EAI documented one sighting of a piping plover in or near the project area, but its occurrence there is very rare, given the high amount of human use and associated disturbances (personal communication, Robert Ernest, EAI August 2009). Only one solitary bird has been observed on the Atlantic beaches of Hutchinson Island, located a considerable distant from the inlet (EAI 2009). Designated critical habitat for wintering piping plovers in the vicinity of the project area occurs south of the project area on Jupiter Island, Martin County, Florida. No critical habitat is designated within the project area.

3.4. HARDBOTTOM

Nearshore hardbottom features along the project area comprise marine components of the Anastasia formation, including lithified shell fragments (especially coquina clam), quartz sand, and calcium carbonate (Cooke and Mossom 1929, Cooke 1945). These features parallel the shoreline, extend through the intertidal and subtidal zones, and range from relatively wide expanses of pavement-like platforms with ledges to isolated patches of rocks. The ledges typically have exposed vertical faces and overhangs along the shoreward edges. Nearshore hardbottom in this area is ephemeral in nature due to high wave energy and a dynamic sedimentary environment. The majority of hardbottom observed in the project area includes partially exposed rock with sand veneers of varying depths (CSA International 2010a).

The sabellariid tubeworm *Phragmatopoma lapidosa* (also known as *P. caudata*) colonizes nearshore hardbottom in portions of the project area. This colonial species settles in intertidal and subtidal hardbottom areas and uses sand particles in concert with a mucoprotenaceous cement to construct dwelling tubes resulting in construction of reef-like structures (Gore et al. 1978, Nelson and Demetriades 1992; Kirtley 1994; Drake et al. 2007). This "worm rock" is somewhat ephemeral, as storm waves and burial by sediments may destroy the structures (CSA International 2009a) and the species typically constructs the worm rock only from early summer through fall. Although *P. lapidosa* is capable of spawning year-round (Eckelbarger, 1976; McCarthy et al. 2003), spawning peaks in summer and fall (McCarthy et al., 2003). Sabellariid worms have an opportunistic life history typified by fast-growth, short time to sexual maturity, and hardiness regarding physical disturbance (McCarthy et al. 2003). Although *P. lapidosa* is quite resilient to turbidity (Main and Nelson 1988), studies evaluating sediment burial tolerance of *P. lapidosa* colonies within St. Lucie and Brevard counties found increased mortality linked to both depth of sediment cover and duration of burial (Main and Nelson 1988, Sloan and Irlandi 2008).

Off the east coast of Florida, the structure provided by nearshore hardbottom and associated worm rock supports locally moderate to high diversities and abundances of algae, fishes, and invertebrate groups including sponges, hydroids, mollusks, crustaceans, bryozoans, ascidians, and cnidarians (Kirtley 1966, Gore et al. 1978, Nelson 1989, Lindeman and Snyder 1999, Coastal Planning and Engineering [CPE] 2006a, CSA International 2010a). Considered important nursery habitat for juvenile fishes (Sloan and Irlandi 2008), nearshore hardbottom also provides shelter and/or foraging grounds for sea turtles (Ehrhart et al. 1996, Wershoven and Wershoven 1989, Holloway-Adkins 2001, CSA International 2009a). Corals and/or octocorals occur only rarely in the project area due to seasonal changes (decreases) in water temperature; however, hardbottom areas in deeper water further offshore support octocorals and several genera of scleractinian corals including *Oculina*, *Siderastrea*, and *Phylangia* (CSA International 2010a).

Substantial geological evidence suggests that nearshore hardbottom and/or worm rock are also important in the maintenance and persistence of beaches and barrier islands by dissipating wave energy and retaining sediments, and thus increasing the volume of standing sand on beaches adjacent to large worm rock habitat (Gram 1965; Kirtley 1966, 1967; Multer and Milliman 1967; Kirtley and Tanner 1968; Mehta 1973; Kirtley 1974).

Multispectral image analysis of 2008 aerial photography with transect ground verification showed an estimated 10.4 acres of hardbottom habitat in the nearshore Atlantic Ocean adjacent to the project (from FDEP reference monuments R-87.7 to R-90.3, and from R-98 to R-115+1,000 ft [St. Lucie/Martin County line]). Of the total hardbottom area, the Applicant's preferred project would impact 1.08 acres (i.e., the amount of hardbottom occurring within the project equilibrium toe of fill – ETOF) (Coastal Tech 2009: Design Document).

In the northern section of the project area, between reference monuments R-87.7 and R-90.3, hardbottom includes an often discontinuous, low- to medium-relief landward edge with a significant worm rock component (CSA International 2010a: Community One). The landward edge of hardbottom is relatively close to shore (within 10 to 20 meters of the mean high water line – MHWL). Hardbottom continues seaward as a series of well-exposed, shore-parallel ledges with vertical relief of 0.5 to 1.0 meters, alternating with partially-exposed, pavement-like platforms. Generally, hardbottom covers the nearshore area in a relatively continuous distribution (CSA International 2010a).

Data from the first 50 meters seaward of the shore along each of two monitoring transects surveyed (located at reference monuments R-88.7 and R-90.4) during summer 2009 (CSA International 2010a) provided detailed estimates of biological benthos within the footprint of the northern section of the project area. Percent cover of macroalgae ranged from 10% to 70% at individual sampling locations (in situ 0.5 square meter quadrats), with an average cover of 35.8%. Red algae dominated the algal community with an average cover of 20.3%, followed by turf algae at 9.5%. Dominant species of red algae included *Laurencia* sp., *Bryothamnion seaforthii*, *Chondria* sp., and *Hypnea musciformes*. Cover of sessile macroinvertebrates ranged from 0% to 15% at individual sampling locations, with an average cover of 1.3%. *P. lapidosa* dominated the invertebrate community, although other observed invertebrates included hydroids, solitary (*Cinachyra* sp.) and encrusting sponges, encrusting tunicates, holothuroids (*Holothuria grisea*), and various small crabs and other mollusks.

In the southern section of the project area, between reference monuments R-99.5 and R-107, hardbottom occurs as a discontinuous landward edge (CSA International 2010a). The landward edge of hardbottom in this region generally occurs as an undercut coquina rock ledge with low relief and relatively less biotic cover than HB (CSA International, 2010a: Community Two).

Between monument R-98.5 to just north of R-104, the landward edge of hardbottom is located approximately 40 meters from the MHWL, whereas from just south of monument R-104 to R-107, the landward edge of hardbottom lies approximately 17 to 40 meters from the MHWL. Hardbottom continues seaward as a series of low-relief ledges with a vertical relief of 0.25 to 1.0 meters, alternating with partially-exposed, pavement-like platforms. Worm rock occurs in the intertidal zone near monuments R-101, R-104.5, and R-105.9; hardbottom (including worm rock) in this section showed more evidence of sand-scouring and a dynamic sedimentary environment with minimal to moderate algal cover dominated by turf algae.

Data from the first 50 meters seaward of the shore along each of the six monitoring transects (located at monuments R-100, R-101, R-102, R-103.2, R-104.5, and R-105.9) surveyed during summer 2009 (CSA International 2010a) provided more detailed estimates of biological benthos within the footprint of the southern section of the project area. Cover of macroalgae ranged from 0% to 60% at individual sampling locations, with an average cover of 25%. Turf algae dominated the vegetative community with an average cover of 18.5%, followed by green algae at 4.7%. *Caulerpa prolifera* almost completely dominated the green algae component present along the transects. This species commonly occurs on hardbottom outcrops in the intertidal zone in St. Lucie and Indian River counties (CSA International 2009b, 2010b). Sessile macroinvertebrates on transects located between monuments R-100 and R-103.2 provided only a small fraction of total cover (0% to 3% at individual sampling locations) and included no worm rock.

Cover of sessile macroinvertebrates at monuments R-104.5 and R-105.9 ranged from 0% to 100% due to localized abundance of worm rock in the intertidal zone. Other invertebrates observed along these transects included barnacles, hydroids, solitary (*Cinachyra* sp.) and encrusting sponges, encrusting tunicates, holothuroids (*Holothuria grisea*), and various small crabs and other mollusks. **Table 3.4-1** provides a synopsis of dominant hardbottom community components, ordered by relative abundance.

Table 3.4-1. Taxa on Nearshore Hardbottom Habitat in Eastern Central Florida (CSA International 2010a)

Common and Scientific Names	Life Stages Present	Abundance Within the Project Area	Seasonal Presence
Macroalgae	Spores and adults	Common	Year-round (perennial species) and May-October (annual species)
Invertebrates (crustaceans, echinoderms, and mollusks)	Larvae, juveniles, and adults	Common	Year-round
Sponges	Larvae, recruits, and adults	Common	Year-round
Sabellariid worm rock (*Phragmatopoma lapidosa*)	Larvae, recruits, and adults	Common to Occasional	Year-round
Scleractinian Corals (e.g. *Phylangia americana*, *Siderastrea* spp., *Oculina* spp.)	Larvae, recruits, and adults	Rare	Year-round
Octocorals	Larvae, recruits, and adults	Rare	Year-round

3.5. FISH AND WILDLIFE RESOURCES

3.5.1. NEARSHORE SOFT BOTTOM COMMUNITIES

Soft bottom macrobenthic and infaunal communities located within the nearshore portion of the project area experience highly dynamic conditions due to the high energy wave action in the intertidal surf zone. As discussed in **Section 3.4**, a portion of this environment comprises hardbottom (worm rock and exposed Anastasia rock formations). The remainder of the nearshore environment consists of medium to coarse quartz sand and shell hash coarse carbonate/quartz sand bottom with the assemblages of plants and animals that use these soft bottom habitats.

The project area also includes three large shore-parallel sand gaps that lack nearshore hardbottom structures or feature only very small patches of exposed hard substrate. These areas locate between FDEP reference monuments R-98 to R-99, R-107 to R-109, and R-112 to R-2 and consist of primarily fine, unconsolidated sand substrate (CSA International 2010a). In tropical and subtropical areas, the ghost crab genus Ocypode typically dominates the upper beach area. Mole crabs (*Emerita*), haustoriid amphipods, and bivalves (*Donax*) are numerical dominants in the intertidal area, while polychaetes, other amphipod species, and bivalves increase in abundance in the subtidal nearshore areas (Pearse et al. 1942, Dahl 1952, Spring 1981).

Gorzelany and Nelson (1987) studied the effects of beach nourishment on intertidal and subtidal infaunal communities in the Indialantic and Melbourne Beach area. The study listed 99 taxa with *Donax* spp. as the numerically dominant group followed by the polychaete *Happloscoloplos fragilis*, the amphipods *Parahaustorius longimerus* and *Bathyporeia parkeri*, and the polychaete *Paraonis fulgens*. Species richness and density decreased in winter, increased in spring and summer, and decreased in fall. These population shifts did not seem attributable to beach nourishment effects but rather to natural seasonal variations.

3.5.2. OFFSHORE BORROW AREA SOFT BOTTOM COMMUNITIES

Infaunal organisms present in the soft bottoms offshore central east Florida are predominantly common invertebrates including crustaceans, echinoderms, mollusks, polychaetous annelids, and interstitial bryozoans. Infaunal populations exhibit both seasonal and spatial variability in distribution and abundance, due to temperature, sediment topography, bathymetry, and sediment composition, including particle size and organic content (Hammer et al. 2005).

Epifaunal invertebrates commonly occurring on the soft bottoms offshore central east Florida include lady crabs (*Ovalipes* spp.), calico scallop (*Argopecten gibbus*), calico box crab (*Hepatus epheliticus*), iridescent swimming crab (*Portunus gibbesii*), brown shrimp (*Farfantepenaeus aztecus*), white shrimp (*Litopenaeus setiferus*), striped sea star (*Luidia clathrata*), and arrowhead sand dollar (*Encope michelini*). The distribution on the epifaunal invertebrates listed above exhibit distributions that are depth-, temperature-, and sediment type-related (Hammer et al. 2005).

Distribution of interstitial bryozoans has recently been studied at shoals located offshore St. Lucie County, including the St. Lucie Shoal. In a study conducted for the U.S. Army Corps of Engineers, Brostoff (2002) identified an average of 19 different species located within the samples from the St. Lucie Shoal, with *Cupuladria doma* the exceedingly dominant species collected. Previous studies of Capron Shoal (north of St. Lucie Shoal) by Winston and Håkansson (1986) described the interstitial bryozoan population as adapting to interstitial conditions, characterized by small size, simplified, colony structure, and very early reproduction. The distribution of encrusting bryozoans extends along sandy continental shelves, providing a food source for crustaceans, echinoderms, and mollusks (Winston and Håkansson 1986).

3.5.3. NEARSHORE HARDBOTTOM FISH ASSEMBLAGES

An investigation conducted during 2009 (CSA International 2010b) documented the fish assemblage associated with the nearshore hardbottom of the project area. The extant assemblage comprised primarily reef-associated species generally expected for the region (Gilmore et al. 1981, CSA International 2009a). Although the assemblage consisted of 70 species, numerical dominants included black margate (*Anisotremus surinamensis*), silver porgy (*Diplodus argenteus*), newly settled grunts (*Haemulon* spp.), sailors choice (*H. parra*), hairy blenny (*Labrisomus nuchipinnis*), and porkfish (*A. virginicus*). The grunt family (Haemulidae), represented by nine taxa, dominated taxonomically in the project area.

CSA International (2010b) identified 24 federally managed species during 2009 surveys of the nearshore hardbottom (**Appendix H: EFH Assessment**). Represented primarily by the grunt and jack families, many of these managed species also occurred as newly settled or juvenile stage individuals, indicating that the area serves as effective juvenile habitat for most of the managed species recorded. The South Atlantic Fishery Management Council (SAFMC) (1998) includes most of the managed species within the snapper-grouper complex, but the survey also reported two other managed species, a coastal pelagic species (Spanish mackerel, *Scomberomorus maculatus*) and a coastal shark (nurse shark, *Ginglymostoma cirratum*). Other economically important or notable species observed near or over hardbottom, but not formally recorded during timed swims or in strip transects during the survey include snook (*Centropomus undecimalis*), bonnethead shark (*Sphyrna tiburo*), tarpon (*Megalops atlanticus*), cobia (*Rachycentron canadum*), king mackerel (*Scomberomorus cavalla*), and Florida pompano (*Trachinotus carolinus*). Although not a federally managed fishery species, the striped croaker (*Bairdiella sanctaeluciae*), a federally designated species of special concern (Gilmore and Snelson 1992) was recorded at five of the survey transects.

3.5.4. COASTAL PELAGIC FISH

The major coastal pelagic families occurring in inshore and coastal waters of the project area include ladyfish, anchovies, herrings, mackerels, jacks, mullets, bluefish, and cobia. Coastal pelagic species migrate over the region’s shelf waters throughout the year. Some species form large schools (e.g., Spanish mackerel), while others (e.g., cobia) travel alone or in smaller groups. Many coastal pelagic species inhabit the nearshore environment along beaches and barrier islands of eastern Florida (Gilmore et al., 1981; Peters and Nelson 1987). Commonly occurring species in the project area include anchovies (*Anchoa* spp.), menhaden (*Brevoortia* spp.), scaled sardine (*Harengula jaguana*), striped mullet (*Mugil cephalus*), hardhead catfish (*Ariopsis felis*), and Florida pompano (*Trachinotus carolinus*). Concentrations of anchovies, herrings, and mullets in nearshore areas may attract larger predatory species (particularly bluefish, blue runner, jack crevalle, sharks, and Spanish mackerel). The presence and density of most coastal pelagic fish species depend on water temperature and quality, which vary spatially and seasonally.

3.5.5. SEABIRDS AND SHOREBIRDS

A number of seabirds and shorebirds may occur along the beach and offshore the project area, including a number of species considered birds of conservation concern by the Migratory Bird Treaty Act of 1918 (MBTA). These species are likely to become candidates for listing under the Endangered Species Act. According to the Florida Natural Areas Inventory (FNAI 2010), all of the migratory species, except for the Audubon's shearwater, marbled godwit, and the semipalmated sandpiper, have been observed within St. Lucie County. These species all use sandy beaches for foraging and/or nesting and, therefore, could occur along the project area both onshore and offshore.

3.6. ESSENTIAL FISH HABITAT

The Magnuson-Stevens Fishery Conservation and Management Act requires identification of habitats needed to create sustainable fisheries and comprehensive fishery management plans with habitat inclusions. The act also requires preparation of an EFH assessment (**Appendix H**) and coordination with NMFS when EFH impacts occur.

EFH is defined as "those waters and substrates necessary to fish for spawning, breeding, feeding or growth to maturity" [16 U.S.C. § 1801(10)]. Waters are defined as aquatic areas and their associated physical, chemical, and biological properties that fish use during each stage of their cycle. Substrate includes "sediment, hardbottom, structures underlying the waters, and associated biological communities." Necessary is defined as "the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem." Fish includes finfishes, mollusks, crustaceans, and all other forms of marine animal and plant life other than marine mammals and birds, whereas "spawning, breeding, feeding, or growth to maturity" covers the complete life cycle of species of interest.

The SAFMC (South Atlantic Fisheries Management Council) holds responsibility for managing fisheries and habitat in the waters of the project area and has produced several Fisheries Management Plans (FMPs) for single and mixed groups of species. All of these FMPs — including those for penaeid shrimp, spiny lobster, red drum, snapper-grouper (reef fishes) and coastal migratory pelagics — were amended in a single document (SAFMC 1998) to address EFH within the South Atlantic region. In addition to the FMPs prepared by the SAFMC, highly migratory species (e.g., tunas, billfishes, sharks, and swordfish) are managed by the Highly Migratory Species Management Unit, Office of Sustainable Fisheries, NMFS. This Office prepared an FMP for highly migratory species that includes descriptions of EFH for sharks, swordfish, and tunas (NMFS 1999). The SAFMC recently prepared a Fishery Ecosystem Plan (SAFMC 2009a,b) that expands many of the EFH descriptions provided in the Habitat Plan (SAFMC, 1998). Note that some of the species managed by SAFMC and NMFS also fall under the jurisdiction of the Atlantic States Marine Fisheries Commission (ASMFC) in order to further coordinate the conservation and management of the states' shared fishery resources.

Of the species or species groups managed by the SAFMC and NMFS, the following may occur within the project area for at least a portion of their life history:

- *Sargassum*
- Coral, coral reefs, and live/hardbottom habitats
- Penaeid shrimp
- Spiny lobster
- Red drum
- Coastal pelagic fishes
- Reef fishes (snapper-grouper complex)
- Dolphin and wahoo
- Highly migratory species

The following subsections accounts briefly describe the EFH for these species and their respective life stages.

3.6.1. SARGASSUM

Sargassum, a seaweed that permanently drifts at the surface in warm waters of the Atlantic Ocean (SAFMC 2002), normally occurs in scattered individual clumps ranging from 10 to 50 centimeters (4 to 20 inches) in diameter. Accumulation of *Sargassum* and other flotsam in lines often indicates a convergence zone between water masses. Convergence zones are sites of considerable biological activity; many species (including juvenile sea turtles and pelagic fishes) gather along these zones regardless of whether *Sargassum* or other flotsam is present (Carr 1986).

Floating *Sargassum* provides habitat for as many as 100 fish species at some point in their life cycle, but only two spend their entire lives there: the sargassumfish and the sargassum pipefish (Adams 1960, Dooley 1972, Bortone et al. 1977, SAFMC 2002). Most fishes associated with *Sargassum* are temporary residents (e.g., juveniles of jacks, triggerfishes, flyingfishes, and filefishes). Adults of these species reside in shelf or coastal waters (McKenney et al. 1958, Dooley 1972, Bortone et al. 1977, Moser et al. 1998, Comyns et al. 2002). In addition, several larger species of recreational or commercial importance, including dolphin, yellowfin tuna, blackfin tuna, skipjack tuna, little tunny, and wahoo, feed on the small fishes and invertebrates attracted to *Sargassum* (Morgan et al. 1985).

Sargassum is considered a Habitat of Particular Concern (HAPC) for dolphin and wahoo (SAFMC 2003).

3.6.2. CORAL, CORAL REEFS, AND LIVE/HARDBOTTOM HABITATS

The FMP for coral, coral reefs, and live/hardbottom habitats covers a range of organisms and structural features including reef-building stony corals, black corals, octocorals, sea pens, sea pansies, and live/hardbottom.

The regional distributions and ecological requirements of sea pens and sea pansies are not well known, but their recognized EFH includes muddy, silty bottoms in subtidal to outer shelf depths within a range of salinity and light penetration that includes the offshore borrow site proposed for this project.

The live/hardbottom FMP category also includes nearshore hardbottom. **Section 3.4** provides a description of nearshore hardbottom habitat occurring in the project area. On a broad scale, nearshore hardbottom occurs in patches along the east coast of Florida. Considered EFH for coastal pelagic and reef fish management units (SAFMC 1998, 2009), these patches provide important ecological functions for plants, invertebrates, marine turtles, and fishes of the region (CSA International 2009a). The reef-building polychaete *Phragmatopoma lapidosa* augments the structural complexity of nearshore hardbottom.

The only HAPC for coral, coral reefs, and live/hardbottom within the project area is the *P. lapidosa* worm reefs found on nearshore hardbottom in water depths of 0 to 4 m.

3.6.3. PENAEID SHRIMP

Penaeid shrimp managed by the SAFMC and found in the project area include brown shrimp (*Farfantepenaeus aztecus*), pink shrimp (*F. duorarum*), and white shrimp (*Litopenaeus setiferus*).

EFH for penaeid shrimp encompasses the series of habitats used during their life history, which has two basic phases: the adult/juvenile benthic phase and the planktonic larval/post-larval phase (SAFMC 1998). Benthic adults aggregate to spawn in shelf waters over coarse, calcareous sediments. Eggs attached to the females' abdomen hatch into planktonic larvae. These larvae and subsequent post-larval shrimp feed on zooplankton in the water column and make their way into inshore waters. For the inshore phase of the life history, post-larval shrimp settle to the bottom and resume a benthic existence in estuaries that provide rich food sources as well as shelter from predation. Young penaeid shrimp prefer shallow-water habitats with nearby sources of organic detritus such as estuarine emergent wetlands or mangrove fringe.

3.6.4. SPINY LOBSTER

EFH for spiny lobster (*Panulirus argus*) consists of hardbottom, coral reefs, crevices, cracks, and other structured bottom in shelf waters. Juvenile habitat, located in nearshore waters, ranges from massive sponges, mangrove roots, and seagrass meadows to soft bottom with macroalgal clumps. Spiny lobster has a complex series of planktonic larvae transported by small-scale currents as well as the Gulf Stream (SAFMC 1998). At least two life stages (adults and planktonic larvae) occur in the project area. Adult spiny lobster frequently occur in holes, crevices, and under ledges provided by regional nearshore and offshore hardbottom habitats. On occasion these adults migrate, walking in groups or single file lines along the open seafloor. Thus, this species would likely occur in the water column of the project area, mostly near the borrow site where the advective effect of offshore currents would prevail).

3.6.5. RED DRUM

Red drum (*Sciaenops ocellata*), a member of the drum family Sciaenidae, occur in the project area. EFH for red drum includes tidal freshwater, estuarine emergent wetlands (e.g., flooded salt marshes, brackish marsh, and tidal creek systems), mangrove shorelines, seagrasses, oyster reefs and shell banks, unconsolidated bottom (e.g., soft sediments), ocean high-salinity surf zones, and artificial reefs (SAFMC 1998, 2009). Red drum EFH particular to the project area includes ocean high-salinity and surf zone.

HAPCs for red drum include coastal inlets, state-designated nursery habitats of particular importance to red drum, documented sites of spawning aggregations, and habitats for submerged aquatic vegetation (SAFMC 1998). In many areas throughout the geographic range of red drum, mature adults migrate from inshore waters to spawn in coastal and offshore areas. Tagging studies conducted in inshore waters of the area have documented that red drum will migrate to ocean inlets such as St. Lucie or Ft. Pierce, presumably to spawn (Stevens and Sulak 2001, Tremain et al. 2004). Adult and subadult red drum occur in the nearshore waters of the region during late summer and fall months.

Other sciaenids found in the project area include kingfish (*Menticirrhus* spp.), sand drum (*Umbrina coroides*), and striped croaker (*Bairdiella sanctaeluciae*). The SAFMC does not manage these species, but they may serve as prey for other managed species in the project area (e.g., reef fishes and coastal pelagic species). The State of Florida considers the striped croaker a species of special concern.

3.6.6. COASTAL PELAGIC FISHES

The major coastal pelagic families occurring in nearshore waters of the project area are ladyfish (*Elops saurus*), anchovies (*Anchoa* spp.), herrings (Harengula spp, *Opisthonema oglinum*, and *Sardinella aurita*), mackerels (*Scomberomorus* spp.), jacks (*Caranx* spp., *Trachinotus* spp), mullets (*Mugil* spp.), bluefish (*Pomatomus saltatrix*), and cobia (*Rachycentron canadum*). Coastal pelagic species migrate over the region's shelf waters throughout the year. Some species form large schools (e.g., Spanish mackerel *[Scomberomorus maculatus*]), while others travel alone or in smaller groups (e.g., cobia). Many coastal pelagic species inhabit the nearshore environment along beaches and barrier islands of eastern Florida (Gilmore et al. 1981, Peters and Nelson 1987). Commonly occurring species in the project area include anchovies, menhaden (*Brevoortia* spp.), scaled sardine (*Harengula jaguana*), striped mullet (*Mugil cephalus*), hardhead catfish (*Ariopsis felis*), and Florida pompano (*Trachinotus carolinus*). Larger concentrations of anchovies, herrings, and mullets that aggregate in nearshore soft or hardbottom areas may attract larger predatory species particularly bluefish, blue runner (*Caranx crysos*), jack crevalle (*Caranx hippos*), requiem sharks (*Carcharhinus* spp., *Negaprion brevirostris*, and *Galeocerdo cuvier*) and Spanish and king mackerel (*Scomberomorus cavalla*). The distribution of most species depends on water temperature and quality, which vary spatially and seasonally.

Coastal pelagic species managed by the SAFMC include cobia, Spanish mackerel, king mackerel, cero (*Scomberomorus regalis*)*,* and little tunny (*Euthynnus alletteratus*) (SAFMC 1998). Various life stages of all these species may occur in the project area (**Appendix H: EFH Assessment**).

EFH for coastal pelagic species includes *Phragmatopoma* reefs (worm reefs) off the central coast of Florida; ocean high-salinity surf zone; and nearshore hardbottom located south of Cape Canaveral. This EFH also includes sandy shoals of capes and offshore bars and high-profile rocky bottom and barrier island ocean-side waters from the surf zone to the shelf break zone from the Gulf Stream shoreward (including *Sargassum)*. In addition, EFH for coastal migratory pelagic species includes all coastal inlets and state-designated nursery habitats (SAFMC 1998).

3.6.7. REEF FISHES (SNAPPER-GROUPER COMPLEX)

The Reef Fish Management Unit comprises 73 species from 10 families. Although the fisheries and adult habitat of most of these species exist well offshore of the project area, the young stages of several reef fishes use nearshore hardbottom (e.g., Gilmore et al. 1981, SAFMC 1998, Lindeman and Snyder 1999, Lindeman et al. 2000). SAFMC (1998) identified the following habitats as EFH for early life stages of reef fishes: attached macroalgae, seagrasses, salt marshes, tidal creeks, mangrove fringe, oyster reefs and shell banks, soft sediments, artificial reefs, coral reefs, and hard/live bottom. The project and surrounding areas include soft bottom and hard/live bottom. Nearshore hardbottom has been identified as an important habitat for many of the 73 members of the Reef Fish Management Unit (SAFMC 1998). **Appendix H** (EFH Assessment) details reef fish species with EFH in the project area.

Generally, reef fishes spawn offshore and then release eggs and larvae into the water column. Reef fishes such as lane snapper (*L. synagris*) and grunts (*Haemulon* spp., *Anisotremus surinamensis*, and *A. virginicus*) have similar life cycles, and their early life stages also occur in the inshore waters of the project area (CSA International 2009a, Lindeman et al. 2000). Nearshore hardbottom provides an important connection to the cross-shelf developmental pathways undertaken by many reef species (Lindeman et al. 2000).

3.6.8. DOLPHIN AND WAHOO

Dolphin (*Coryphaena hippurus*) and wahoo (*Acanthocybium solandri*) are oceanic species associated with the western edge of the Gulf Stream. Dolphin and wahoo travel near this edge as they migrate through the project area near the offshore borrow site. Closely associated with the Gulf Stream, all life stages (eggs, larvae, juveniles, and adults) of these species could occur in the project vicinity near the offshore borrow site (**Appendix H: EFH Assessment**). Dolphin, tunas, and wahoo feed on small fishes and invertebrates associated with drifting *Sargassum* and other flotsam (Manooch et al. 1983, Manooch and Mason 1984, Morgan et al. 1985). HAPC for dolphin and wahoo is *Sargassum*.

3.6.9. HIGHLY MIGRATORY SPECIES

Worm et al. (2003) identified eastern Florida as an area supporting a high diversity of oceanic predators, such as sharks, billfishes (Istiophoridae), and tunas (*Thunnus* spp. and *Katsuwonus pelamis*), considered under the Highly Migratory Species Management Unit.

Many species, including tunas, swordfish (*Xiphias gladius*), and billfishes, may occur in the project area near the offshore borrow site because of its proximity to the Gulf Stream current. Swordfish and bluefin tuna (*Thunnus thynnus*) migrate through the Florida Straits and into the eastern Gulf of Mexico to spawn (NMFS 1999, 2009). *Sargassum* is important habitat for various life stages of the swordfish, billfishes, and tunas. Sailfish (*Istiophorus platypterus*), blue marlin (*Makaira nigricans*), and white marlin (*Tetrapturus albidus*) regularly occur offshore east Florida.

Coastal sharks are managed under the highly migratory species group. These species commonly occur during various life stages in inland and nearshore shelf waters of east Florida. In the project area, several managed shark species occur, including nurse (*Ginglymostoma cirratum*), hammerheads (*Sphyrna* spp.), and requiem sharks (Gilmore et al. 1981, CSA International 2009a, Gilmore 2009). Some of these species are very wide-ranging and loosely associated with a variety of habitats (e.g., soft bottom, hardbottom, and the water column). Others, particularly the nurse shark, are associated closely with hardbottom habitats. **Appendix H: EFH Assessment** presents EFH identified by NMFS (1999, 2009) for coastal shark species .

The reef-building activities of the sabellariid polychaete *P. lapidosa* augment the nearshore hardbottom features in the project area. This species, defined as a foundational or structural species (see **Section 3.4**), forms large colonies commonly referred to as worm rock (Kirtley and Tanner 1968, McCarthy 2001). In addition to fish species, worm rock supports associated assemblages of organisms, such as decapod crustaceans (Gore et al. 1978).

3.7. OFFSHORE BORROW AREA RESOURCES

The sand shoals offshore of the project area are well-developed shore-face connected and isolated linear shoals oriented north-to-south. These features, depositional in nature, exhibit varying degrees of morphological change in response to local hydrodynamic conditions. Sand shoals form as an irregularity on the seafloor and then grow in response to local coastal processes (waves, tides, currents).

Surveys (CPE 2006b) of the proposed borrow area identified clean sand from 4 to 20 feet deep. Side-scan and magnetometer investigations conducted during the surveys indicated no hardbottom habitats near the borrow area (CPE 2006b).

Hammer et al. (2005) performed a study to examine the implications of sand removal from potential borrow areas off the east central Florida shelf. The study, focused on federal waters seaward of the current St. Lucie Shoal borrow area, found that waves passing over the shoals turned toward the shoreline sooner than in other areas the same distance offshore. The study concluded that waves refracting over the shoals within the entire investigation area produced area region of increased wave heights landward of each shoal and a corresponding region of decreased wave heights immediately south of the sites. However, the wave refraction over the entire St. Lucie Shoal (federal waters and state waters portion) is potentially more significant than the impact to waves from the other shoals located farther offshore because the St. Lucie shoal area of influence is more focused along the shoreline (Hammer et al. 2005).

Sedimentary habitats such as sand shoals support a variety of invertebrates and demersal fishes, as described in **Section 3.5.2**. Invertebrates using shoals include infaunal and epifaunal species represented primarily by annelid worms, gastropods, bivalves, crustaceans, and echinoderms. Demersal feeding fishes prey on most of these species. A number of sand shoal studies conducted along the eastern coast of the U.S. have documented the use of sand shoals as fish habitat (Able and Hagan 1995, Slacum et al. 2006, Walsh et al. 2006, Vassilides and Able 2008, Gimore 2009). CSA International et al. (2009) generally characterized use of sand shoals by fishes at several spatial scales. At broad scales (1 to 100 square kilometers), fishes may use shoal features as guideposts during migrations, local movements, or spawning. At intermediate scales (tens to hundreds of square meters), different parts of individual shoals may represent different foraging areas or shelter from predators or waves and currents. At smaller scales (e.g., meters to centimeters), sediment texture (fine sand to shell fragments), variable bedform structures, and biogenic structures may provide important predator refuge or foraging areas. Considering this spatial framework, most fundamental ecological functions of shoals for fishes fall into the categories of spawning, shelter, or foraging.

Gilmore (2009) synthesized unpublished information and data and interviewed local anglers to determine the importance of the east Florida sand shoals, including the St. Lucie Shoal, to fishes. The report inferred from the various data sources that more than 200 species potentially use shoals for orientation, refuge, spawning, and feeding sites. Interviews with anglers confirmed that shoals served as aggregating points for small pelagic fishes such as menhaden, Spanish sardine, thread herring, and false pilchard. These species are important prey for numerous managed species, particularly from the coastal pelagic and highly migratory groups.

3.8. COASTAL BARRIER RESOURCES

In 1982, Congress signed the Coastal Barrier Resources Act (CBRA) prohibiting federal expenditures (direct or indirect) for development of designated undeveloped coastal barriers and their associated aquatic habitat, including wetlands, estuaries, and inlets. The three primary goals of the CBRA include

- Minimize loss of human life by discouraging development in high risk areas
- Reduce wasteful expenditure of federal resources
- Protect the natural resources associated with coastal barriers

One Coastal Barrier Resource System (CBRS) map unit, P-11 (Hutchinson Island), lies partially within and adjacent to the project area (**Figure 3.11-1**).

The May 27, 2009 FWS CBRA Consistency Determination letter (**Appendix I: Pertinent Correspondence**) describes the project area CBRA Unit P-11 as follows: "located east of Port St. Lucie, Florida, supports suitable habitat for species listed under the Endangered Species Act of 1973, as amended (87 Stat. 884; 16 U.S.C. 153 1 et seq.), including the threatened piping plover (*Charadrius melodus*), threatened loggerhead sea turtle (*Caretta caretta*), endangered green sea turtle (*Chelonia mydas*), endangered leatherback sea turtle (*Dermochelys coriacea*), and endangered hawksbill sea turtle (*Eretmochelys imbricata*)." The same letter states, "the beaches of St. Lucie County support the fifth highest nesting density of sea turtles in Florida."

3.9. WATER QUALITY

The State of Florida classifies the waters offshore of the project area as Class III waters, which are designated as suitable for recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife. The predominant issue that affects water quality in offshore waters in south Florida is turbidity, considered a good measure of water quality. Turbidity is a measure of the loss in transparency of water due to the presence of suspended particulates — the more total suspended solids in the water, the cloudier it appears and the higher the turbidity. Turbidity is measured in nephelometric turbidity units (NTUs), which is measured by the intensity of light scattered passing through the water sample.

3.10. HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

The coastline within the project area is located adjacent to predominantly residential, commercial, and recreational areas. No known industrial activities produce hazardous, toxic, and/or radioactive wastes adjacent to the project site; no know industrial activities discharge effluents near the shoreline; and no known records of such past activities exist. Sediments within the littoral zones of the project area, as well as sediments from the borrow areas, comprise particles of a large grain-size. Normally, contaminants do not adhere to materials with such properties. Sediments in the potential borrow sites are sufficiently removed from shipping lanes or other potential contaminant sources. Hence, pollutants are unlikely to have contaminated them.

3.11. AIR QUALITY

St. Lucie County lies within the Southeast Florida Intrastate Air Quality Region, as established by 40 CFR Part 81.49. The U.S. Environmental Protection Agency (EPA) (40 CFR Part 81.310) designates St. Lucie County as being in attainment with National Ambient Air Quality Standards for ozone, nitrogen dioxide, carbon monoxide, total suspended particulates, and sulfur dioxide. Air quality in St. Lucie County exceeds national standards. The EPA has not made a designation for lead in southeastern Florida.

Ambient air quality along coastal St. Lucie County is generally good due to prevalent ocean breezes from the northeast through the southeast. Coastal development and the popularity of the beaches area all contribute to the presence of motorized vehicles and vessels in the project area at any given time. The usually present sea breezes along the Ft. Pierce shore readily disperse airborne pollutants. This project will not require air quality permits.

3.12. NOISE

Ambient sources of noise within the project area include beach and nearshore recreational activities, breaking surf, boat and vehicular traffic, and noise from adjacent residences. Because St. Lucie County has many seasonal residents and tourists, many more residents are present in the homes and condominiums located along the project area during the winter months. Their presence results in more ambient noise along the beach front as well as more boating traffic during the winter tourist season.

3.13. AESTHETIC RESOURCES

An aesthetic or visual resource is a broad term used to identify the particular scenic qualities that define a place or landscape. The sandy beaches and blue waters of the Atlantic Ocean found along South Hutchinson Island define the aesthetic resources within the project area. Upland development consisting of high and low rise commercial and residential development, vacant lands, and recreational beach access areas backs the coastline. Vacant lands and beach access areas are generally vegetated with low lying shrubby dune plants such as sea oats (*Uniola paniculata*), with occasional interspersed railroad vine (*Ipomoea pescapre*), sea grapes (*Coccoloba uvifera*), and sea purslane (*Sesuvium* sp.). Residents and guests of the numerous condominiums, resorts, and hotels within the project area enjoy the aesthetically pleasing panoramas of the Atlantic Ocean. However, the general project area does not include sites designated under 40 CFR 81.407 as a Class I Federal Area, where visibility is an important value.

Figure 3.11-1. CBRS Unit P-11 (Hutchinson Island), St. Lucie County South Beach and Dune Restoration Project

Erosional processes currently occurring within the project area distract from the aesthetics and will continue to reduce the width of the beach area and related aesthetic value. According to the Conditions Assessment Report (Coastal Tech 2009: Attachment P), an average 60 feet of dune separated the buildings and the sandy beach. The analysis found project area beaches generally eroded and the shoreline generally in retreat, with the greatest volumetric loss occurring between reference monuments R-90 and R-100. From R-103 to R-109, the slightly accreted beaches advanced slightly seaward.

3.14. RECREATION RESOURCES

Beaches within the project area are somewhat less congested than other nearby beaches due to limited public beach access points and distance from the heavily populated areas of Ft. Pierce, Port St. Lucie, and Stuart. Project area beaches provide an appealing and relaxing South Florida atmosphere. The extent of the project area includes only five public beach access points (**Table 3.14-1**), leaving the remaining areas accessible primarily to residents or guests in condominiums, resorts, and hotels.

Recreational usage along the beaches within the project area includes shore-based water sports such as scuba diving, snorkeling, surfing, surf fishing, and kayaking. Additionally, visitors use area beaches for sunbathing, picnicking, and exercising. Boating is a popular recreational pastime for many residents and tourists to the area. Fishing, lobstering, scuba diving, and snorkeling often start from boats in nearshore hardbottom areas. Offshore angling may occur near the proposed borrow site despite the absence of known, identified fish havens near the borrow area. Numerous boat ramps and marinas in Ft. Pierce, Jensen Beach, and Stuart provide access to the Atlantic Ocean through the Ft. Pierce Inlet located approximately 10 miles north and the St. Lucie Inlet located 7.5 miles south of the project area.

Table 3.14-1. Public Access along the Project Area

Public Access	Area (acres)	Amenities	Parking Spaces	Security
Walton Rocks Beach Park	24	Bathrooms, showers, picnic tables with cover, life guard, dog friendly	100	No
Herman's Bay Beach Access	1	ADA access to boardwalk, picnic tables, pavilion	12	No
Normandy Beach Park	1	ADA access to path, no facilities	20	No
Dolman Beach Park	143.7	ADA access, dune crossover, pavilion, restrooms and shower	100	No
Waveland Beach Park	3.6	ADA access to boardwalk, sitting area, restrooms, showers, lifeguard	100	Yes

In 2007 and 2008, Dr. William Stronge conducted surveys of beach users on South Hutchinson Island (Stronge, 2008: R-77 to St. Lucie/Martin County line). The surveys estimated that almost 250,000 people used the beach during the survey year. **Table 3.14-2** (from Stronge 2008) reports survey results for project area beaches as total counts and as a percentage of the total survey counts. Interviews determined that an average beachgoer would be willing to pay $5.70 ("willingness to pay per beach visit") for the privilege of using the beach.

Table 3.14-2. Project Area Beach Visitor Survey Results (from Stronge 2008, Reported in Coastal Tech 2009: Design Document, Appendix C: Benefit Cost Analysis)

Project Area Beaches	Summer 2007		Winter 2007-08		Total	
	Count	% of Total	Count	% of Total	Count	% of Total
Walton Rocks Public	6,067	7.1	12,533	8.0	18,600	7.7
Sand Dollar	2,241	2.6	4,618	3	6,859	2.8
Herman's Bay Public	5,097	6	10,676	6.8	15,773	6.5
Normandy Public	5,437	6.4	8,651	5.5	14,088	5.8
S. of Normandy - to Island Dunes	4,020	4.7	13,489	8.6	17,509	7.2
Dollman Public	5,562	6.5	21,601	13.8	27,163	11.2
Ocean Towers - Nettles Island	9,012	10.6	22,411	14.3	31,423	13
Oceana - North of Waveland	8,340	9.8	10,957	7	19,297	8
Waveland Public	21,685	25.4	25,137	16.1	46,822	19.4
Island Crest South to County Line	17,904	21	26,150	16.7	44,054	18.2
Total	85,365	100%	156,222	100%	241,588	100%

Using the Stronge (2008) data, Coastal Tech (2009: Design Document Appendix C, Benefit Cost Analysis) estimated recreational value and benefit of the existing condition, proposed alternative, and the 70 ft berm alternative (**Table 3.14-3**).

Table 3.14-3. Estimated Recreational Value and Benefit of Two Alternatives Compared to the Existing Conditions (From Coastal Tech 2009: Design Document Appendix C: Benefit Cost Analysis)

Alternative	Beach Area (sq ft)	Recreation Value	Recreational Benefit
Existing Conditions	637,838	$1,159,730	N/A
Beach Fill to Restore 1972 Dune with 35' Berm	913,515	$1,709,420	$549,690
Beach Fill to Restore 1972 Dune with 70' Berm	1,573,117	$2,916,599	$1,756,869

3.15. NAVIGATION

The majority of the vessel traffic within the project area is associated with recreational boating and fishing. Vessels occurring in nearshore areas are likely used for fishing or diving along the shallow hardbottom areas. The northern extent of the project area is located approximately 10 miles from the Ft. Pierce Inlet and the southern end of the project area is located approximately 7.5 miles from the St. Lucie Inlet. Commercial vessels including shipping vessels, barges, tugs, fishing charter boats, commercial fishing vessels, and sightseeing boats use the Port of Ft. Pierce; however, the shipping lanes and entrance channel do not occur within the project area. The proposed borrow area is not located near any shipping lanes or channels.

3.16. HISTORIC PROPERTIES

New South Associates (2008) conducted a Phase I cultural resources survey for the project in October 2007). The survey extended from the Martin/St. Lucie County line to approximately 0.5 miles north of the St. Lucie County Nuclear Power Plant.

The Phase I survey consisted of background desktop research, field investigations including surface reconnaissance, systematic shovel testing, metal detection in areas adjacent to recorded locations of historic shipwrecks, artifact identification and analysis, and report preparation. With the exception of two shipwreck sites, all previously recorded historic and prehistoric sites are located well outside of the project area — on or west of the back dune along or west of U.S. A1A. The field survey uncovered no evidence of the previously recorded sites.

The study recommended that the project avoid areas near previously recorded underwater sites and undisturbed areas of back dune where previously recorded sites are located. The survey found no evidence of any new or previously recorded sites or artifacts over 50 years old in the project fill template. The final report recommended a finding of no project effect on cultural resources listed, or eligible for listing, in the National Register of Historic Properties, or otherwise of historical, archaeological, or architectural value; and recommended no further investigation of the area. The Florida Department of State – Division of Historical Resources reviewed the survey report and, in a letter to the U.S. Army Corps of Engineers (USACE) on 15 April 2008, concurred with the report findings and recommendations.

Between September 2007 and June 2008, a remote sensing survey of borrow area 5 located offshore of Martin and St. Lucie Counties was conducted by SEARCH for the U.S. Army Corps of Engineers (USACE), Jacksonville District. For Coastal Tech, in December 2010, SEARCH conducted a remote sensing survey of the portion of borrow area 5 that was not previously investigated. SEARCH determined that the proposed activities within borrow area 5 will have no effect on cultural resources, listed, or eligible for listing and recommended no further investigation of the area. The Florida Department of State - Division of Historical Resources reviewed both reports and issued letters dated 4 September 2008 and 20 January 2011 concurring with the reports findings and recommendations.

3.17. SOCIOECONOMICS

The Hutchinson Island South CDP (census designated place) subsumes the majority of the project area. The 2000 population census reported 4,846 residents with a population density of 1,074 residents per square mile, 5,889 housing units, and a median household income in 1999 dollars of $43,329. The 2007 and 2008 demographic estimates show these numbers continue to increase. In 2007, the estimated total population for this census place rose to 5,263 people, while the population density rose to 1,167 people per square mile. The 2008 estimated household median income rose to $53,967 (University of Florida Bureau of Economic and Business Research, 2010).

The existing and proposed uplands uses in the project area are predominately high-density multifamily condominium developments. The project area includes four county beachfront parks available for public use — Walton Rocks Beach Park, Dollman Beach Park, Normandy Beach Park, and Waveland Beach Park; no user fees are associated with these facilities. The project area does not contain shoreline armoring structures such as seawalls or groins. Based on zoning maps for the project area, shoreline zoning designations include 86% multifamily, 12% conservation, and 2% commercial.

St. Lucie County employs about 10% of its workforce in the leisure industry and bases much of its economy on tourism. Many businesses, particularly along the coast, are tourist-oriented enterprises that rely on revenue generated from tourists.

Fisheries contribute significant (billions of dollars) economic (Kidlow 2008) and aesthetic value to east central Florida. The commercial fishery landings for St. Lucie and Martin Counties alone were worth $3 to $9 million annually between 1990 and 2007 (Gilmore

2008). In addition to commercial fishing, recreational fisheries, tournaments, and artificial reef programs contribute significantly to the local economy.

East central Florida coastal counties possess not only significant inshore fisheries (snook, red drum, spotted sea trout, tarpon, sheepshead, gray snapper, stone/blue crab, shrimp, clam/oyster) but also major lucrative coastal and offshore fisheries (sailfish, swordfish, dolphin, king and Spanish mackerel, pompano, grouper and snapper, shrimp, scallop, spiny lobster) (Gilmore 2008). Local fishing tournaments attract competitors from throughout the United States.

4. ENVIRONMENTAL EFFECTS

4.1. GENERAL ENVIRONMENTAL EFFECTS

The beneficial effects of sand renourishment along the proposed project area include establishing a larger buffer beach to protect upland infrastructure and populations against storms and flooding, and creating additional dry beach for turtle nesting and recreational activities.

Beach renourishment will likely increase sea turtle nesting habitat provided that the nourishment sand remains compatible with naturally occurring beach sediments and that the project includes compaction and escarpment remediation measures.

Dredging operations and the subsequent placement of sediment on the beach have the potential to adversely affect flora and fauna on a scale ranging from months to decades (Defoe et al. 2009). Dredging equipment may entrain animals; the act of dredging will impact habitats by removal; placement of sand on the beach will bury benthic and beach fauna; physical contact with dredging equipment and vessels (i.e., impact) would harm the animals, as would physical barriers imposed by the presence of dredging equipment (i.e., pipelines); and placement of dredged material in various locations (i.e., covering, compaction, escarpment formation, etc.) could cause avoidance behavior, or reduce available habitat, or otherwise impact those species using the project area (USFWS 2007). Grooming of the beaches to reduce compaction, scarp formation, etc. may also cause temporary impacts.

Potential negative effects to sea turtles include possible destruction of nests deposited within the boundaries of the proposed project during construction, harassment in the form of construction-related disturbance to or interference with female turtles attempting to nest within the construction area or on immediately adjacent beaches, artificial lighting-induced disorientation of hatchlings as they emerge from the nest and crawl to the water, and behavior modification of nesting females from escarpment formation within the project area during the nesting season. Escarpments can cause false crawls or selection of marginal or unsuitable nesting areas to deposit eggs. At the dredging site, the dredge may entrain swimming turtles.

The quality and/or color and the density of the donor sand could affect the ability of female turtles to excavate a nest, the nest incubation environment, and the ability of hatchlings to emerge from the nest and result in abnormal sex ratios of the hatchlings.

Several protective measures can minimize some of these potential negative impacts. Scheduling renourishment projects outside the sea turtle nesting window provides the most important means of avoiding and minimizing impacts. During construction, daily preconstruction (or pre-dawn) surveys to locate nests and the relocation of all found nests to a safe hatchery will reduce impacts within the construction area. During 24 hour/day operations, minimum and shielded construction lighting will reduce turtle avoidance of the beach and false crawl behavior. The use of sand similar to the “natural” or “existing” beach — considering grain size distribution including a level of "fines" (material passing through a #200 sieve) not exceeding 5% — will likely provide a sand suitable for natural nesting, incubation, and hatching behaviors. After construction, beach tilling can reduce sand density to appropriate levels. Likewise, post-construction removal of scarps prior to sea turtle nesting season will allow turtles to crawl up the beach to safe nesting elevations. Annual escarpment and compaction monitoring typically occurs on an annual basis just before the sea turtle nesting season for 3 years after construction.

The proposed project will likely produce more favorable environmental conditions than exist at present, although construction operations will produce some temporary adverse effects as discussed above. In addition, the presence of construction equipment and personnel will temporarily detract from the aesthetics of the beach. Construction will include best management practices to ensure efficient construction and to minimize the time that equipment and personnel remain on project area habitats.

Immediately after renourishment, the dredged sand may appear darker than the sediments on the preconstruction beach, which may detract from the aesthetics of the beach. However, the natural working of the dredged sediments by sunlight, rain, and wind will lighten the color of the sediments in a relatively short time.

After construction, the beach profile typically undergoes a period of reworking by waves and currents. The beach fill reclines to an "equilibrium profile" within about one year of a renourishment event. Direct burial of shoreline bottom (benthic) habitat would occur within this equilibrium profile. The first year post-construction would include a potential for greater-than-normal erosion of the dry beach along with possible loss of sea turtle nests. Turbidity could increase in the nearshore waters during renourishment and as the beach profile equilibrates. The use of hopper dredges will eliminate potential impacts associated with hydraulic dredge swing anchors and cables. The Applicant has demonstrated that pipeline corridors located in areas without hardbottom habitat will provide the path to transfer material from the dredge to the beach fill areas. Collars fitted on the (up to) 3-foot diameter pipelines — used for the sand transfer from the hopper dredge to the beach — will minimize contact with the ocean bottom. Anchors or spuds for the hopper dredge will locate entirely in sand bottom. Weekly monitoring of all pipelines to shore will identify any sand movement or leaks that could impact the environment. The dredging contractor will conduct continuous leak monitoring by real-time inspection of pipeline pressure fluctuation.

Construction activities will result in temporary disturbance to sandy benthic habitats in the borrow area and along the nearshore zones in the immediate proximity of construction activities. Since these sandy beaches and subtidal areas are populated by small, short-lived organisms with great reproductive potential, these communities usually recover relatively quickly from environmental disturbances such as beach restoration projects (ATM 1991, Taylor Engineering 2009). A literature review by Newell et al. (1998) concluded that sand and gravel sediments may require 2-3 years to reestablish. In another literature review, Brooks et al. (2006) concluded that available literature on offshore benthic assemblages (OBA) residing along the U.S. east and Gulf of Mexico continental shelf suggested that "general recovery'' from anthropogenic disturbance to benthic assemblages on the continental shelf occurs between three months and 2.5 years."

St. Lucie County contractors conducted numerous investigations, including sidescan sonar, aerial photography, and underwater diver-verified reef characterization studies along the project reach. These investigations revealed the presence of hardbottom tracts consisting of limestone outcroppings scattered along the project beach between FDEP reference monuments R-87.7 and R-90.3, and R98 to about R-115+1,000 feet. The landward edge of hardbottom occurs in general between 10 and 50 meters offshore depending on location. CSA International (2008 and 2010) identified three hardbottom types. The first includes relatively persistent low-medium (1 – 3 feet) relief limestone outcrops including various algae and the marine bristle worm, *Phragmatopoma lapidosa.* The second includes low-medium relief ephemeral outcropping with biological activity dominated by turf algae. The site probably provides a physical refuge area for fauna. A third medium (3 – 6 feet) relief habitat occurs at the seaward edge of hardbottom (nearly 1,000 feet from shore). This persistent habitat (not often covered by sand) contains a much greater plant and animal diversity than the other two habitats.
Interpretation of aerial photography identified about 10.4 acres of hardbottom in the nearshore of the project beach. The Applicant's preferred project would bury about 1.08 acres of this habitat. A UMAM calculation (**Appendix D**) indicated that successful creation of 0.98 acres of artificial reef would offset expected project impacts.

4.2. VEGETATION

4.2.1. BEACH FILL TO RESTORE THE 1972 DUNE WITH A 35-FOOT BERM (APPLICANT'S PREFERRED PLAN)

The Applicant's preferred plan will result in minor, short-term impacts to herbaceous dune vegetation that inhabits the upper beach and foredune. Fill placement will not occur landward of the dune crest. The proposed beach and dune restoration will help stabilize and protect the dune vegetative communities from storm surge and erosion. Adding sand to the system will promote further dune habitat development.

The Applicant's preferred plan includes plans to re-establish the plant community by planting a mix of native dune species that, depending on nursery availability, may include sea oats (*Uniola paniculata*), beach sunflower (*Helianthus debilis*), railroad vine (*Ipomoea pes-caprae*), and dune panic grass (*Panicum amarum*). The planting plan specifies planting units installed on 18-inch centers in staggered rows on the dune crest.

4.2.2. BEACH FILL WITH NO IMPACT TO EXISTING HARDBOTTOM

This alternative would result in equivalent impacts to vegetation as the Applicant's preferred plan.

4.2.3. BEACH FILL TO RESTORE THE 1972 BEACH AND DUNE

This alternative would result in equivalent impacts to vegetation as the Applicant's preferred plan.

4.2.4. BEACH FILL TO RESTORE THE 1972 DUNE WITH A 70-FOOT BERM

This alternative would result in equivalent impacts to vegetation as the Applicant's preferred plan.

4.2.5. SOUTH SEGMENT BEACH AND DUNE RESTORATION; NORTH SEGMENT DUNE RESTORATION ONLY (NORTH SEGMENT DUNE RESTORATION ONLY)

This alternative would result in equivalent impacts to vegetation as the Applicant's preferred plan.

4.2.6. BEACH AND DUNE RESTORATION WITH T-HEAD GROINS

This alternative would result in equivalent impacts to vegetation as the Applicant's preferred plan.

4.2.7. NO-ACTION (STATUS QUO)

The No-Action alternative would adversely affect vegetation within the project area. Continued erosion of the beach would result in continued loss of vegetated beach and dune habitats. Additionally, continued erosion may cause landowners to implement alternative armoring measures such as seawalls to protect their property. These measures could result in negative impacts to the dune system by altering profile and displacing vegetation.

4.3. THREATENED AND ENDANGERED SPECIES

4.3.1. BEACH FILL TO RESTORE THE 1972 DUNE WITH A 35-FOOT BERM (APPLICANT'S PREFERRED PLAN)

4.3.1.1. Sea Turtles

4.3.1.1(a). Nesting Habitat

Of the threatened and endangered species found in coastal St. Lucie County, nourishment activities are more likely to impact sea turtles, simply by their ubiquity during nesting season. Escarpments obstructing beach accessibility, altered beach profiles, different sand color characteristics, and increased sand compaction often hinder nesting success the first year after nourishment (USFWS, 2005, 2007). Impacts of a nourishment project on sea turtle nesting habitat are typically short-term because natural processes rework a nourished beach in subsequent years. Constant wave and current action reworks the beach and reduces sand compaction and the frequency of escarpment formation while the sun bleaches darker sand (USFWS 2005).

St. Lucie County initiated an emergency beach fill project in 2005 as a result of damages to project area beach and dunes during hurricanes Frances and Jeanne in 2004. The upland sand used in the 2005 emergency fill project was incompatible with the native beach (PBS&J 2005). A dune remediation project excavated, removed, and replaced the incompatible sand with more carefully characterized beach-compatible sand (Coastal Tech 2009: Design Document). The area of sand replacement provided an opportunity for an unplanned experiment comparing turtle nesting on natural sand with turtle nesting on replacement beach sand. Below, the term “nourished” will apply to the section of beach that required remediation and “natural” to the adjacent sections of beach not impacted and remediated.

Nesting success provides a gauge of beach nesting suitability (EAI 2009a). Less suitable beaches tend to have lower nesting success (a higher false crawl to nest ratio). EAI performed sea turtle nesting surveys for the St. Lucie beach before the storms and after replacement of poor quality sand with suitable quality sand (EAI 2007, 2008, 2009a). **Table 4.3-1** summarizes nesting success between 2003 and 2009 for the three sea turtle species nesting on nourished and natural beach sections of the project area beach (EAI 2009a; personal communication, Beth Brost, FWC; personal communication, Jonathan Gorham Inwater Research Inc., 2010).

During 2005, all three marine turtle species exhibited lower nesting success on the nourished beach than on the natural beach. Loggerhead and green turtles exhibited the greatest differences (**Table 4.3-1**). In the years before the emergency nourishment (2003 – 2004) and the years following 2005 (2006 – 2009), all three species displayed similar or greater nesting success on the nourished beach than on the natural beach. EAI (2009a) attributed the apparent improvement in the suitability of the restored beach for nesting to changes in beach conditions resulting from the dune remediation project.

With the exception of 2005, the nourished area generally showed higher loggerhead and green turtle nest densities (**Table 4.3-2**: nests per kilometer). In 2005, all three species showed lower nest densities on the nourished beach than on the natural beach. Beginning in 2006, however, loggerhead and green turtle have since maintained nest densities on the nourished beach similar to or greater than densities on the natural beach. According to EAI (2009a), the shift back to pre-2005 patterns in the relative distribution of loggerhead and green turtle nest densities in the nourished beach suggests that the remediation project succeeded in mitigating the negative effects of the poor quality sand placed during the 2005 dune restoration project and in providing nesting habitat similar to natural conditions.

Table 4.3-1. Sea Turtle Nesting Success (%) in Project Area: Restored (INBS Zone V-X) vs. a Natural (L-N) Beach

	2003		2004		2005		2006		2007		2008		2009	
Species	**Nourished**	**Natural**	**Nourished**	**Natural**	**Nourished**	**Natural**	**Nourished**	**Natural**	**Nourished**	**Natural**	**Nourished**	**Natural**	**Nourished**	**Natural**
Loggerhead	65.7	54.2	59.6	49.6	14.1	33.0	55.9	49.5	52.1	50.6	58.9	56.3	57.3	46.2
Green	75	37.5	46.8	50	11.4	39.6	42.0	30.0	41.3	27.0	65.1	47.4	54.3	45.8
Leatherback	80	87.5	80	74.1	31.0	40.0	78.6	80.0	80.8	83.3	78.4	77.8	76.9	74.3

Source Data 2003, 2004, 2009: INSB Zones L, V-X - personal communication: Beth Brost, Florida Fish and Wildlife Commission Index Nesting Beach Survey Database as of July 1, 2010. Zones L, V-X include data between May 15 and August 31. INSB Zones M and N - personal communication: Jonathan Gorham, Inwater Research Group, Inc. May 6, 2010. Zones M and N are year totals.
Source Data 2005 to 2008: EAI, 2009a

Table 4.3-2. Sea Turtle Nesting Density (nests/km) in Project Area: Restored (INBS Zone V-X) vs. a Natural (L-N) Beach

	2003		2004		2005		2006		2007		2008		2009	
Species	**Nourished**	**Natural**	**Nourished**	**Natural**	**Nourished**	**Natural**	**Nourished**	**Natural**	**Nourished**	**Natural**	**Nourished**	**Natural**	**Nourished**	**Natural**
Loggerhead	224.3	164.3	175.3	170.3	110	205	205.0	117.3	163.3	123.3	211.7	157.7	198.3	133.3
Green	6	1	7.3	6	9.7	12.3	5.3	9.0	30.7	9.3	11.0	8.0	8.3	7.3
Leatherback	4	9.3	2.7	6.7	0.3	5.3	1.3	3.0	6.7	7.7	4.0	5.0	6.7	8.7

Source Data 2003, 2004, 2009: INSB Zones L, V-X - personal communication: Beth Brost, Florida Fish and Wildlife Commission Index Nesting Beach Survey Database as of July 1, 2010. Zones L, V-X include data between May 15 and August 31. INSB Zones M and N - personal communication: Jonathan Gorham, Inwater Research Group, Inc. May 6, 2010. Zones M and N are year totals.
Source Data 2005 to 2008: EAI, 2009a

Note regarding data sources: Due to the overlap of several data sources, the table includes year totals when available. This is the case of the nesting data for INBS zone M and N representing the natural beach north of the project area. Due to discrepancies between EAI (2009a) report data, which includes yearly data, and the FWC dataset (INBS Zones V – X), which only contains nesting data between May 15 and August 31, EAI (2009a) provided **Table 4.3-1** data between 2006 and 2008, while the FWC dataset provided data for years 2003, 2004, and 2009. For consistency, nesting density per kilometer of shoreline in **Table 4.3-2** contains only data from Inwater Research and FWC.

Leatherback nest densities did not show the same post-remediation increase in nest densities seen in loggerhead and green turtle nest densities (**Table 4.3-2**, EAI, 2007, 2008). Leatherback nest densities remained lower on the nourished beach throughout the study period. During all seven years (2003 – 2008), fewer leatherback turtles nested on the nourished beach than on the natural beach. These data suggest that the changes in beach conditions between 2003 and 2008 affected leatherback nesting to a lesser extent than loggerhead or green turtle nesting.

The data presented above supports the hypothesis that impacts from beach nourishment to sea turtle nesting and habitat are short term (about 1 year) assuming the placement of appropriate quality sand. The data also suggest that the beach nourishment could have positive effects on sea turtle nesting through the creation of additional high quality beach habitat. Continuous monitoring of the sea turtle activity in the project area will dictate whether the changes observed between 2003 and 2009 will repeat themselves in the next projects.

In summary, within the first year of the project (construction year up to a year post-construction), the impacts to sea turtles associated with the project may include

- Disturbance of nesting female turtles attempting to nest within the construction area or on adjacent beaches as a result of construction activities
- Behavior modification of nesting females from beach escarpment formation during a nesting season. Example: behavioral changes could result in false crawls or selection of marginal or unsuitable nesting areas to deposit eggs
- Destruction, damage, or burial of existing nests during nourishment activities
- Effects to eggs and hatchlings from changes in the physical and chemical characteristics of the nourished beach. Example: the quality of the placed sand could affect the ability of female turtles to nest, the suitability of the nest incubation environment, and the ability of hatchlings to emerge from the nest.
- Lighting-induced disorientation of hatchling turtles on beaches adjacent to the construction area as they emerge from the nest and crawl to the water
- Alteration (burial) of nearshore exposed hard substrate (feeding grounds to sea turtle juveniles) during and subsequent to nourishment activities

USFWS biological opinions for similar projects recognize that placement of sand on a critically eroded beach can enhance sea turtle nesting habitat if the sand placed is highly compatible (i.e., grain size, shape, color, etc.) with naturally occurring beach sediments at the recipient site, and compaction and escarpment remediation measures are properly adopted (USFWS 2005). State and federal permit requirements for beach nourishment projects usually address avoidance and minimization of potential impacts to nesting turtles and nesting habitat. Permit conditions may include consideration of

- Sand quality: a major component of the beach nourishment permitting process is to assure the sand placed on the beach is compatible with the natural beach.
- Timing of construction activities: USFWS has jurisdiction over sea turtles on the beach (nesting adults, incubating eggs, and hatching young). In St, Lucie County, USFWS requires that nourishment activities avoid the peak nesting

season from May 1 through October 31 to minimize the impact to nesting sea turtles. Projects requiring night-time construction activities, state and federal permits will restrict night-time construction to specific areas, usually no more than 500 feet in length.

- Pre-nesting season compaction monitoring, mechanical tilling, and grading of the beach: compaction monitoring, mechanical tilling, and grading of the beach can greatly reduce or eliminate the effects of increased sand compaction and scarp formation. Post-construction compaction monitoring or tilling before nesting season is a state and federal permit requirement after nourishment activities, and for three years after project completion. State and federal agencies require tilling of project area beaches if penetrometer testing demonstrates compaction in excess of 500 pounds per square inch at any two adjacent sampling stations or depths. Additionally, leveling of escarpments greater than 18 inches in height or 100 feet in length must occur before nesting season begins.
- Relocation of sea turtle nests: USFWS requires monitoring and relocating sea turtle nests between March 1 and April 30 if nourishment activities occur during that period.
- Hardbottom impacts: avoidance and minimization of hardbottom impacts also comprise major considerations during review of any beach nourishment permit application.

Because the proposed project would use sand with characteristics very similar to the native beach sand, sand quality is unlikely to have negative effects on sea turtle nesting or hatchling emergence. However, the Applicant's preferred plan — Beach Fill to Restore the 1972 Dune with a 35-ft Berm — may still have negative effects on nesting sea turtles (from nesting disturbance, sand compaction, potential for scarp formation, artificial lighting) during the first post-construction year. As natural processes rework the nourishment area and the beach equilibrates, the increase in beach area provided by this alternative may have a long-term benefit on sea turtle nesting.

4.3.1.1(b). Inner Shelf Habitat

Impact-producing factors (IPFs) associated with the Applicant's preferred plan that may potentially affect sea turtles include

- Vessel traffic
- Entrainment by hopper dredge drag heads
- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during and subsequent to nourishment activities
- Turbidity
- Underwater noise and vibration from dredging activities

Vessel Traffic

Dredge, dredge support, and construction vessel traffic associated with the Applicant's preferred plan raises a chance of collision between these vessels and sea turtles. The risk would vary depending upon location, vessel speed, and visibility. As discussed in

Section 3.3.1.2, most sea turtles occur within nearshore waters off St. Lucie County and waters of the continental shelf. All life stages (hatchling, juvenile or subadult, and adult) may occur within the project area. During the hatching season, researchers believe that hatchling turtles leave their nesting beaches and swim offshore to areas of water mass convergence. A moving vessel may have difficulty spotting hatchling and juvenile turtles in these areas, especially when the individuals lie within patches of floating *Sargassum*. Adult turtles are generally visible at the surface during periods of daylight and clear visibility.

To reduce the risk of impacts from dredging and vessel strikes, the project will comply with the "Sea Turtle and Smalltooth Sawfish Construction Conditions" (NOAA Fisheries, 2006) and "Vessel Strike Avoidance Measures and Reporting for Mariners" issued by NOAA Fisheries, Southeast Region. Trained NMFS-approved protected species observers will man the dredge vessel and dredge support vessel. Operators and crews receive instructions to maintain a vigilant lookout for turtles during offshore transits and maneuvers.

Despite these precautions, turtles may prove very difficult to spot from a moving vessel when resting below the water surface, during nighttime, and during periods of inclement weather. A collision between a sea turtle and a slow moving vessel is unlikely. Adult, subadult, and perhaps juvenile turtles are capable of avoiding moving dredge-related vessels when these vessels operate within limited areas at slow to relatively slow speeds. Impacts from collisions are, consequently, unlikely to affect marine turtle populations adversely within the project area.

Entrainment by Hopper Dredge Drag Heads

Entrainment within hopper dredge drag heads may injure or kill sea turtles , particularly within areas of soft sediment in ship channels where turtles are known to bury themselves partially when resting (National Research Council Committee on Sea Turtle Conservation 1990). Sea turtles have also been observed to partially bury themselves in soft sediments that have settled into previous dredge borrow pits (Michals 1997p; Spring and Snyder, personal observations off Hobe Sound, Florida). Numerous methods have been implemented to reduce the number of turtle takes during hopper dredge operations, including special turtle deflecting hopper dredge drag heads, relocation trawling, dredging windows, and the implementation of trained protected species observers during dredging operations (http://el.erdc.usace. army.mil/tessp/pdfs/ 1997SADBO.pdf).

The proposed offshore borrow area is unlikely to serve as a refuge for sea turtles, as it is an area of bare sand positioned along the inner continental shelf, proximal to numerous areas of emergent hard substrate that would provide shelter.

NMFS-approved protected species observers will man the hopper dredge, which will come equipped with a sea turtle deflecting drag head deflector within the proposed borrow site (http://el.erdc.usace.army.mil/seaturtles/docs/observercriteria.pdf) during all dredging operations. Even with these measures in place, incidental take(s) of sea turtles during dredging remains a possibility.

Alteration (Burial) of Exposed Nearshore Hardbottom

Impacts to juvenile sea turtle species from the proposed project due to the loss of developmental nearshore habitat (hardbottom) will depend on the extent of buried nearshore hardbottom within the project area and the longevity of that burial (before currents disperse the sand). The project will displace juvenile turtles (i.e., prevent them from using these areas) as long as project sand covers macroalgae and seafloor structures. Hardbottom impacts estimated from 2008 aerial photography total 1.08 acres, about 10% of the total 10.4 acres nearshore of the project footprint. Therefore, the impact, considered minor, is unlikely to adversely affect sea turtles within the project area by displacing juveniles.

Turbidity

Several activities during construction will affect water quality. Dredging and sand placement on the beach face will produce turbidity at the borrow site and along the shoreline. The limited extent and short duration of the reduced water clarity and implementation of proper design and Best Management Practices (BMPs) should reduce the magnitude and extent of temporary impacts of project activities. Therefore, any potential impacts on sea turtles are considered negligible and therefore unlikely to affect sea turtles within the project area adversely.

Underwater Noise and Vibration from Dredging Activities

Little is known how turtles may respond to noise from offshore activities. In contrast to marine mammals, relatively little is known about sea turtles' hearing ability or their dependency on sound, passive or active, for survival cues. Only two species, loggerhead and green sea turtles, have undergone any auditory investigations. The anatomy of the sea turtle ear does not lend itself to aerial conduction; rather, it lends itself to sound conduction through bone and water (Békésy 1948, Lenhardt 1982, Lenhardt and Harkins 1983). Auditory testing and behavioral studies show that turtles can detect low frequency sounds (Ridgway et al. 1969, Bartol et al. 1999).

Sea turtles could likely hear low frequency underwater noise from construction activities and possibly experience some disturbance. The main noise sources include vessel engines. The most likely impacts would include short-term behavioral changes such as evasive maneuvers, disruption of activities, or short-term departure from the area. Considered negligible, these impacts are unlikely to affect sea turtles within the project area adversely.

4.3.1.2. Marine Mammals

IPFs associated with the proposed action that may potentially affect listed marine mammals include

- Vessel traffic

- Turbidity
- Underwater noise and vibration from dredging activities

Vessel Traffic

Dredge, dredge support, and construction vessel traffic associated with the proposed action raises the chance of collision between these vessels and listed marine mammals. The risk would vary depending upon location, vessel speed, and visibility. As discussed in **Section 3.3.2**, North Atlantic right whales may occur in the project area during the wintering and calving period. Humpback whales may also travel through the middle shelf, offshore of the project area; however, as anticipated, they will not occur within the borrow area or within nearshore waters. Both of these species are large and readily visible at the surface during periods of daylight and clear visibility. Florida manatees may, but are unlikely to occur within the project area. On-board trained and NMFS-approved protected species observers will occupy dredge vessel during all dredging operations, and dredge support vessel operators and crews will receive instructions to maintain a constant lookout for marine mammals during transits and maneuvers.

Despite these precautions, these species may prove very difficult to spot from a moving vessel when they are resting below the water surface, during nighttime, and during periods of inclement weather. However, a collision between a marine mammal and moving vessel is unlikely, as these animals are capable of avoiding moving dredge related vessels, especially when these vessels operate within these limited areas at slow to relatively slow speeds. Impacts from collisions are, consequently, unlikely to affect marine mammal populations within the project area adversely.

Turbidity

Several activities during construction will affect water quality. Turbidity created by borrow area dredging and sand placement on the beach face comprises the primary sources of water quality impacts at the borrow site and along the shoreline. Proper implementation of the approved design and construction BMPs should prove effective in reducing the magnitude and extent of impacts resulting from project activities. Turbidity generation will cease at the completion of construction. Due to the limited extent and short duration of the reduced water clarity, potential projecgt impacts on marine mammals should be negligible.

Underwater Noise and Vibration from Dredging Activities

Potential effects of the elevated background noise levels caused by man-made noise to marine mammals include the following:

- Limiting the detection by the mammals of natural sounds
- Disturbing their normal behavior, resulting in possible displacement from areas
- Causing temporary or permanent reductions in hearing sensitivity

The potential effects depend on the type of marine mammal involved because different marine mammals hear at different frequencies. The levels and types of ambient noise also strongly influence the potential area or zone of influence of a man-made sound. An animal's sensitivity to different sounds varies with frequency, and its response to a sound likely depends strongly on the presence and levels of sound in the frequency band or range of frequencies to which it is sensitive (Ports Corporation of Queensland, 2005). Although underwater noise can affect marine mammals (Richardson et al. 1995), the project does not involve any high energy sound sources that could cause temporary or permanent auditory damage. In general, the sources and levels of underwater noise and vibration generated during the project should cause only minor impacts on marine mammals. The most likely impacts are temporary behavioral responses such as avoidance or altered diving or swimming behavior.

The North Atlantic right whale uses the project area as part of the species' migratory route and as potential calving grounds during the winter months; however, these whales are rare to the project area. The humpback whale is rarely present within the vicinity of St. Lucie County during its spring/fall migration. Manatees have been observed along the coast in the shallow, nearshore waters, though only rarely. Marine mammals would likely avoid areas where a dredge is operating. The project area is an extremely small area when compared to the overall waters used for migration and calving; therefore, the dredging activities may affect, but are unlikely to adversely affect, marine mammals in the project area.

4.3.1.3. Smalltooth Sawfish

IPFs associated with the proposed action that may potentially impact smalltooth sawfish include

- Turbidity
- Underwater noise and vibration from dredging activities
- Entrainment by hopper dredge drag heads

Turbidity

Several activities during construction will affect water quality. The main source of water quality impacts is borrow area dredging and sand placement on the beach face, which will produce turbidity at the borrow site and along the shore. Proper implementation of the approved design and construction BMPs should limit the level and extent of construction-related turbidity. Turbidity generation will cease at the completion of construction. Due to the limited extent and short duration of the reduced water clarity, any potential impacts on smalltooth sawfish should be negligible.

Underwater Noise and Vibration from Dredging Activities

In general, the sources and short-term levels of underwater noise and vibration generated during the project should cause only negligible impacts on smalltooth sawfish. Smalltooth sawfish that may visit the project area during the construction period are likely to move from or avoid disturbance caused by construction activities. These temporary avoidance behaviors should incur negligible impacts on smalltooth sawfish.

Entrainment by Hopper Dredge Drag Heads

The smalltooth sawfish normally inhabits shallow waters (10 m or less) often near river mouths or in estuarine lagoons over sandy or muddy substrates, but may also occur in deeper waters of the continental shelf at depths greater than 20 meters (NMFS 2006). Sawfish encounter a small risk of being entrained in the hopper dredge drag head as it extracts sand from the St. Lucie Shoal. To reduce the risk of impacts from dredging and vessel strikes, the project will comply with the "Sea Turtle and Smalltooth Sawfish Construction Conditions" (NOAA Fisheries 2006). Mitigation measures will minimize entrainment risks. Measures will include the use of sea turtle deflecting drag head deflector, which would also help deflect smalltooth sawfish.

These activities may affect, but are unlikely to adversely affect, smalltooth sawfish individuals in the project area. Disturbances from ongoing activities are likely to displace smalltooth sawfish that may visit the project area during the construction period. These disturbances may result in temporary movement or avoidance of the area.

4.3.1.4. Piping Plover

Wintering grounds for piping plovers include Hutchinson Island. While coastal development has reduced important beach habitat for wintering bird species, beach nourishment can restore beach habitat for many shore birds. However, during the beach renourishment construction phase, some displacement of foraging and resting birds, including piping plovers, may occur. This displacement should last short term. During construction activities, displaced species may use habitats with similar characteristics north and south of the project area.

Beach nourishment activities are more likely to affect birds that use the beach for nesting and breeding are more likely to be affected by than birds that use the area for feeding and resting during migration (USDOI/MMS, 1999). Dredges, pipelines, and other equipment along the beach may displace piping plovers, or cause them to avoid foraging along the shore if they are aurally affected (Peterson et al. 2001). If the sand placed on the beach is too coarse or high in shell content, it can inhibit the birds' ability to extract food particles in the sand (Greene 2002). Fine sediment that reduces water clarity can also decrease the feeding efficiency of birds (Peterson et al. 2001).

Minimal direct impacts to piping plovers should occur from project construction as birds are motile and can avoid construction activities. The disposal of sand on the beach may temporarily interrupt foraging and resting activities of shorebirds that use the project beach area. This limited interruption would occur on the immediate area of disposal and last for the duration of construction. A temporary reduction to the prey base for many shorebirds, which includes the benthic organisms mentioned in **Section 3.5.1**, would also occur in the project area. Recovery from this short-term should occur within about one year after sand placement.

The Endangered Species Act of 1973, the Florida Threatened and Endangered Species Act of 1977, and the Federal Migratory Bird Treaty Act of 1918 protect piping plovers. The threatened species list first included the Atlantic coast population of the piping plover in 1985. To prevent impacts to piping plovers during construction, the project will comply with the USACE-Jacksonville district-wide migratory bird protection policy. Complete migratory bird protection specifications for contracts is available at the website http://www.saj.usace.army.mil/Divisions/Planning/Branches/Environmental/Protection_Environment.htm.

4.3.2. BEACH FILL WITH NO IMPACT TO EXISTING HARDBOTTOM

4.3.2.1. Sea Turtles

4.3.2.1(a). Nesting Habitat

The material proposed for placement comprises beach-quality sand of similar grain size and color to the native beach sand. Therefore, sand quality will not likely have negative effects to sea turtles nesting or hatchling emergence success. However, based on the issues discussed above, the Beach Fill with No Impact to Existing Hardbottom alternative may still incur short-term negative effects on sea turtles nesting from nesting disturbance, sand compaction, potential for scarp formation, artificial lighting, etc. during construction and the first year post-construction. This alternative does not offer significant beach area increase; accordingly, this alternative would most likely include little significant beneficial effect on sea turtle nesting through the creation of additional beach habitat.

4.3.2.1(b). Inner Shelf Habitat

IPFs associated with the Beach Fill with No Impact to Existing Hardbottom alternative that may potentially affect sea turtles on the inner shelf include

- Turbidity
- Underwater noise and vibration from dredging activities

For both of these IPFs, the Beach Fill with No Impact to Existing Hardbottom alternative would cause the same impacts to sea turtles as the Applicant's preferred plan.

4.3.2.2. Marine Mammals

IPFs associated with the Beach Fill with No Impact to Existing Hardbottom alternative that may potentially affect marine mammals include

- Turbidity
- Underwater noise and vibration from dredging activities

The Beach Fill with No Impact to Existing Hardbottom alternative would cause the same impacts to marine mammals from turbidity and underwater noise and vibration from dredging and pumping equipment as the Applicant's preferred plan.

4.3.2.3. Smalltooth Sawfish

IPFs associated with the Beach Fill with No Impact to Existing Hardbottom alternative that may potentially impact smalltooth sawfish include

- Turbidity
- Underwater noise and vibration from dredging activities

The Beach Fill with No Impact to Existing Hardbottom alternative would cause the same impacts to smalltooth sawfish for turbidity and underwater noise and vibration from dredging and pumping equipment as the Applicant's preferred plan.

4.3.2.4. Piping Plover

The Beach Fill with No Impact to Existing Hardbottom alternative would cause the same impacts to piping plovers as the Applicant's preferred plan.

4.3.3. BEACH FILL TO RESTORE THE 1972 BEACH AND DUNE

4.3.3.1. Sea Turtles

4.3.3.1(a). Nesting Habitat

The material proposed for placement comprises beach-quality sand of similar grain size and color to the native beach sand. Therefore, sand quality will not likely have negative effects to sea turtles nesting or hatchling emergence success. However, based on the issues discussed above, the Beach Fill to Restore the 1972 Beach and Dune alternative may still incur short-term negative effects on sea turtles nesting from nesting disturbance, sand compaction, potential for scarp formation, artificial lighting, etc. during construction and the first year post construction. This alternative does not offer significant beach area increase; accordingly, this alternative would most likely include little significant benefit to sea turtle nesting through the creation of additional beach habitat.

4.3.3.1(b). Inner Shelf Habitat

IPFs associated with the Beach Fill to Restore the 1972 Beach and Dune (1972 Design) alternative potentially impacting sea turtles on the inner shelf include

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during and subsequent to nourishment activities
- Turbidity

- Underwater noise and vibration from dredging activities

The Beach Fill to Restore the 1972 Beach and Dune (1972 Design) alternative would cause the same Impacts to sea turtles as the Applicant's preferred plan for turbidity and underwater noise and vibration from dredging and pumping equipment. However, the Beach Fill to Restore the 1972 Beach and Dune (1972 Design) alternative would impact less exposed nearshore hard substrate (0.14 acres of hardbottom) than the Applicant's preferred plan (1.08 acres of hardbottom). This very small, 0.14-acre impact is unlikely to affect sea turtles adversely.

4.3.3.2. Marine Mammals

IPFs associated with the Beach Fill to Restore the 1972 Beach and Dune (1972 Design) alternative that may potentially affect listed marine mammals include

- Turbidity
- Underwater noise and vibration from dredging activities

For both of these IPFs, the Beach Fill to Restore the 1972 Beach and Dune (1972 Design) alternative would cause the same impacts to marine mammals for as the Applicant's preferred plan.

4.3.3.3. Smalltooth Sawfish

IPFs associated with Beach Fill to Restore the 1972 Beach and Dune (1972 Design) alternative that may potentially affect smalltooth sawfish include

- Turbidity
- Underwater noise and vibration from dredging activities

For both of these IPFs, the Beach Fill to Restore the 1972 Beach and Dune (1972 Design) alternative would cause the same impacts to the smalltooth sawfish as the Applicant's preferred plan.

4.3.3.4. Piping Plover

The Beach Fill to Restore the 1972 Beach and Dune alternative would cause the same impacts to piping plovers as the Applicant's preferred plan.

4.3.4. BEACH FILL TO RESTORE THE 1972 DUNE WITH A 70-FOOT BERM

4.3.4.1. Sea Turtles

4.3.4.1(a). Nesting Habitat

The material proposed for placement comprises beach-quality sand of similar grain size and color to the native beach sand. Therefore, sand quality is unlikely to cause negative effects to sea turtles nesting or hatchling emergence success. However, based on the issues discussed above, the Beach Fill to Restore the 1972 Dune with a 70-ft Berm alternative may still have negative effects on sea turtles nesting (i.e., nesting disturbance, sand compaction, potential for scarp formation, artificial lighting) within the first year of the project life. As the beach equilibrates by natural processes in the years following nourishment, the increase in beach area provided by this alternative would have the greatest beneficial effects (compared to the other alternatives evaluated) on sea turtle nesting through the creation of additional beach habitat.

4.3.4.1(b). Inner Shelf Habitat

IPFs associated with the Beach Fill to Restore the 1972 Dune with a 70-Foot Berm alternative that may potentially affect sea turtles on the inner shelf include

- Alteration (burial) of exposed nearshore hard substrate during and subsequent to nourishment activities
- Turbidity
- Underwater noise and vibration from dredging activities

The Beach Fill to Restore the 1972 Beach and Dune with a 70-Foot Berm alternative would create the same turbidity and underwater noise and vibration from dredging and pumping equipment impacts as the Applicant's preferred plan. However, this alternative would create greater impact to exposed nearshore hardbottom (1.34 acres) than the Applicant's preferred plan (1.08. acres of hardbottom impact). The 1.34 acres of impact is still a relatively small percentage of available hardbottom in the area available for use.

4.3.4.2. Marine Mammals

IPFs associated with the Beach Fill to Restore the 1972 Dune with a 70-Foot Berm alternative that may potentially affect listed marine mammals include

- Turbidity
- Underwater noise and vibration from dredging activities

For both of these IPFs, the Beach Fill to Restore the 1972 Beach and Dune with a 70-Foot Berm alternative would cause the same impacts to marine mammals as the Applicant's preferred plan.

4.3.4.3. Smalltooth Sawfish

IPFs associated with the Beach Fill to Restore the 1972 Dune with a 70-Foot Berm alternative that may potentially affect smalltooth sawfish include

- Turbidity
- Underwater noise and vibration from dredging activities

For both of these IPFs, the Beach Fill to Restore the 1972 Beach and Dune with a 70-Foot Berm alternative would cause the same impacts to smalltooth sawfish as the Applicant's preferred plan.

4.3.4.4. Piping Plover

The Beach Fill to Restore the 1972 Beach and Dune with a 70-Foot Berm alternative would cause the same impacts to piping plovers as the Applicant's preferred plan.

4.3.5. SOUTH SEGMENT BEACH AND DUNE RESTORATION; NORTH SEGMENT DUNE RESTORATION ONLY (NORTH SEGMENT DUNE RESTORATION ONLY)

4.3.5.1. Sea Turtles

4.3.5.1(a). Nesting Habitat

The material proposed for placement comprises beach-quality sand of similar grain size and color to the native beach sand. Therefore, sand quality is unlikely to cause negative effects to sea turtles nesting or hatchling emergence success. However, based on the issues discussed above, the North Segment Dune Restoration Only alternative may still have negative effects on sea turtles nesting (i.e., nesting disturbance, sand compaction, potential for scarp formation, artificial lighting) within the first year of the project life on the southern segment. As the beach equilibrates by natural processes in the years following nourishment, the increase in beach area provided by this alternative would have beneficial effects on sea turtle nesting through the creation of additional beach habitat along the south segment, and through the increase in beach width of the north segment due to dispersion of sand from the south segment. Over ten years, such dispersion would lead to a north segment beach of slightly narrower than that resulting from alternatives including beach nourishment of both the north and south segments. Along the north segment, this alternative would reduce the total area of suitable nesting habitat, as only the dune would receive nourishment. In addition, the narrower beach along the north segment could reduce hatching success of nests successfully laid, as nests on narrower beaches stand a greater chance of repeated inundation and washout.

4.3.5.1(b). Inner Shelf Habitat

IPFs associated with the North Segment Dune Restoration Only alternative that may potentially affect sea turtles on the inner shelf include:

- Alteration (burial) of exposed nearshore hard substrate during and subsequent to nourishment activities
- Vessel traffic
- Entrainment by hopper dredge drag heads
- Turbidity
- Underwater noise and vibration from dredging activities

The North Segment Dune Restoration Only alternative would create impacts only along the south segment resulting in less impact to exposed nearshore hardbottom (0.07 acres) than the Applicant's preferred plan (1.08 acres of hardbottom impact). The often discontinuous, low- to medium-relief nearshore hardbottom including worm rock along the north segment would incur impacts. However, modeling has shown that in the long term, sand placed on the south segment would spread into the area north of the south segment and potentially bury additional nearshore hardbottom areas. The 0.07 acres of impact is a small percentage of available hardbottom in the area available for use. For all other IPFs, this alternative would cause the same impacts to inner shelf habitat as the Applicant's preferred plan except that the impacts would occur only along the south project segment.

4.3.5.2. Marine Mammals

IPFs associated with the North Segment Dune Restoration Only alternative that may potentially affect listed marine mammals include:

- Vessel Traffic
- Turbidity
- Underwater noise and vibration from dredging activities

For these IPFs, North Segment Dune Restoration Only alternative would cause the same impacts to marine mammals as the Applicant's preferred plan except that the impacts would occur only along the south segment. There would be no impacts to marine mammals along the north segment of the project area for the initial project implementation.

4.3.5.3. Smalltooth Sawfish

IPFs associated with the North Segment Dune Restoration Only alternative that may potentially affect smalltooth sawfish include:

- Turbidity
- Underwater noise and vibration from dredging activities
- Entrainment by hopper dredge drag heads

For these IPFs, the North Segment Dune Restoration Only alternative would cause the same impacts to smalltooth sawfish as the Applicant's preferred plan except that the impacts would occur only along the south project segment. There would be no impacts to smalltooth sawfish along the north segment of the project area for the initial project implementation.

4.3.5.4. Piping Plover

The North Segment Dune Restoration Only alternative would cause the same impacts to piping plovers as the Applicant's preferred plan for the initial project implementation, except that the impacts would occur only along the south project segment. Shorebirds including the piping plover would encounter a narrower beach for foraging and loafing, but not likely so much narrower as to cause avoidance.

4.3.6. BEACH AND DUNE RESTORATION WITH T-HEAD GROINS

4.3.6.1. Sea Turtles

4.3.6.1(a). Nesting Habitat

The Beach and Dune Restoration with T-Head Groins alternative will reduce the amount of nesting beach by covering nesting habitat with rock to create the groin above mean high water. When exposed, the T-head groins have the potential to entrap hatchlings or alter their behavior. Potential adverse effects during project construction include disturbance to existing nests, which observers may have missed during daily surveys, disturbance of females attempting to nest, and disorientation of hatchlings. Follwing construction, the presence of erosion control structures has the potential to adversely impact sea turtles. The groins may interfere with ingress and egress of the female turtles; trap or obstruct hatchlings as they swim seaward; and attract additional predatory fish, thereby increasing hatchling predation risk. The placement of sand (n the project area and downdrift impact areas would have additional impacts (i.e., nesting disturbance, sand compaction, potential for scarp formation) within the first year of nourishment activity. Tilling the beach and active monitoring and elimination of scarps would mitigate the impacts from compaction and scarp formation. The beaches in the downdrift areas may erode at a rate equivalent to the sand accretion within the project area. Placement of sand as part of the initial project would help mitigate for downdrift effects, but a groin field could still have negative indirect effects on sea turtles nesting (i.e., nesting disturbance, potential for scarp formation) in the downdrift areas.

The construction of the T-head groins with dune and beach restoration is also anticipated to maintain or increase turtle nesting habitat by increasing the beach width and helping preserve that beach width within the project area. Beaches downdrift of the groin field may require nourishment later to compensate for sand accumulated in the project area. As the beach equilibrates by natural processes in the years following nourishment, the increase in beach area provided by this alternative would have beneficial effects on sea turtle nesting through the creation of additional beach habitat. Overall, the increase in beach area provided by this alternative would have beneficial effects on sea turtle nesting through the creation and maintenance of additional beach habitat. Design of the groins for complete burial by sand would reduce the risks to sea turtles. However, it is likely that the groins would become exposed when renourishment was necessary, reducing the period of benefit provided by the buried design.

4.3.6.1(b). Inner Shelf Habitat

IPFs associated with the Beach and Dune Restoration with T-Head Groins alternative that may potentially affect sea turtles on the inner shelf include:

- Alteration (burial) of exposed nearshore hard substrate from T-head groin construction activities
- Alteration (burial) of exposed nearshore hard substrate from subsequent nourishment activities
- Ingress and egress to/from beach
- Vessel traffic
- Entrainment by hopper dredge drag heads for subsequent dredging activities
- Turbidity
- Underwater noise and vibration from T-head groin construction activities
- Underwater noise and vibration from subsequent dredging activities

Similar to the Applicant's preferred plan and other alternatives including beach fill, the Beach and Dune Restoration with T-Head Groins alternative would create turbidity and underwater noise and vibration from construction activities and subsequent dredging and pumping equipment impacts. However, additional turbidity and underwater noise would also occur during subsequent nourishment of downdrift areas if required to offset indirect impacts of the groin field. This alternative would create slightly greater impact to exposed nearshore hardbottom (1.13 acres) from the placement of the T-head groins than the Applicant's preferred plan (1.08 acres of hardbottom impact). The 1.13 acres of impact does not include any potential impacts to hardbottom offshore or other impacts in the downdrift areas that are anticipated to require nourishment. However, this is still a relatively small percentage of available hardbottom habitats.

There has been some speculation that the placement of the T-head groins could impact the ingress and egress of sea turtles to the beach for nesting and the egress of the hatchlings leaving the beach for open water. However, a literature search found no documentation of this potential effect. The T-head groins are in the near shore area; and therefore, are not expected to affect emergent hatchlings crawling to the water. Swimming hatchlings navigate based on wave direction. The smaller waves and gentler wave-generated currents around the T-head groins will help orient hatchlings to the openings between the structures and ease their way into deeper offshore water.

Hatchlings emerge in mass, crawl down to the sea, and immediately begin a 24- to 36-h period of swimming, which has been referred to as the "frenzy" phase of the hatchlings migration away from the coast (Carr 1962). Whelan and Wyneken (2007) showed that the mortality rate among hatchlings rose the longer hatchlings remain in nearshore waters and they speculated that rapid escape from shallow water might comprise a genetic survival mechanism. Large waves and ocean currents often impede hatchlings during their early swimming frenzy to escape shallow water (Whelan and Wyneken 2007). The T-head groins would reduce the large waves reaching the beach and may facilitate turtle hatchling survival rates by reducing wave energy at the shore-sea interface and reducing turbulence in the immediate subtidal. However, the vertical orientation of the groin structures might attract predatory fishes at higher densities than would be present without the groins. These higher densities could lead to increased predation on the hatchlings. Finally, predatory birds may use emergent groins as perches from which to search for prey, including hatchling turtles passing close by the groins.

For the other IPFs, this alternative would cause similar impacts to the inner shelf habitat similar to the Applicant's preferred plan. However, additional impacts (e.g., turbidity, hopper dredge entrainment, underwater noise, vessel traffic, burial of exposed nearshore hard substrate) would occur later from the subsequent nourishment of downdrift areas to mitigate downdrift impact of the groins.

4.3.6.2. Marine Mammals

IPFs associated with the Beach and Dune Restoration with T-Head Groins alternative that may potentially affect listed marine mammals include:

- Vessel traffic
- Turbidity
- Underwater noise and vibration from T-head groin construction activities
- Underwater noise and vibration from subsequent dredging activities

For all of these IPFs, the Beach and Dune Restoration with T-Head Groins Alternative would cause impacts to marine mammals similar to those of the Applicant's preferred plan. However, additional impacts similar to the impacts from the Applicant's preferred plan could also occur from nourishment of downdrift areas to mitigate for groin field indirect impacts.

4.3.6.3. Smalltooth Sawfish

IPFs associated with the Beach and Dune Restoration with T-Head Groins alternative that may potentially affect smalltooth sawfish include:

- Turbidity
- Underwater noise and vibration from T-head groin construction activities
- Underwater noise and vibration from subsequent dredging activities
- Entrainment by hopper dredge drag heads for subsequent dredging activities

For all of these IPFs, the Beach and Dune Restoration with T-Head Groins alternative would cause impacts to smalltooth sawfish similar to those of the Applicant's preferred plan. However, additional impacts, similar to the impacts from the Applicant's preferred plan could also occur later from the nourishment of downdrift areas to offset indirect impacts of the groins.

4.3.6.4. Piping Plover

The Beach Dune Restoration with T-Head Groins alternative would cause impacts to piping plovers similar to those of the Applicant's preferred plan. However, additional impacts similar to the impacts from the Applicant's preferred plan would also occur from the subsequent nourishment of downdrift areas to offset indirect groin impacts.

4.3.7. NO ACTION (STATUS QUO)

4.3.7.1. Sea Turtles

4.3.7.1(a). Nesting Habitat

The No-Action alternative would adversely affect sea turtles that use the project area beaches for nesting. Beach erosion would likely diminish nesting success because it would reduce the total area of suitable nesting habitat. Also, beach erosion would likely reduce hatching success of nests successfully laid, as nests on narrow, eroded beaches become more vulnerable to repeated inundation and washout.

4.3.7.1(b). Inner Shelf Habitat

No IPFs are associated with the No Action alternative to inner shelf habitat for sea turtles; therefore, no impacts would be expected.

4.3.7.2. Marine Mammals

No IPFs are associated with the No Action alternative to habitat for listed marine mammals; therefore, no impacts would be expected.

4.3.7.3. Smalltooth Sawfish

No IPFs are associated with the No Action alternative to habitat for smalltooth sawfish; therefore, no impacts would be expected.

4.3.7.4. Piping Plover

No IPFs are associated with the No Action alternative to habitat for piping plover; therefore, no impacts would be expected.

4.4 HARDBOTTOM

4.4.1. BEACH FILL TO RESTORE THE 1972 DUNE WITH A 35-FOOT BERM (APPLICANT'S PREFERRED PLAN)

IPFs associated with the Applicant's preferred plan that may potentially affect nearshore hardbottom include

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during and subsequent to nourishment activities
- Alteration of exposed nearshore hardbottom and associated epibenthos resulting from the sand delivery pipelines
- Turbidity

Alteration (Burial) of Exposed Nearshore Hardbottom

Impacts to nearshore hardbottom from the proposed project depend on depth of burial, sand characteristics, and duration of coverage. The proposed project will permanently (for regulatory purposes) bury 1.08 acres of hardbottom habitat. Burial of nearshore hardbottom would result in a local reduction of macroalgae and invertebrates that could modify the nearshore food web (greater loss of macroalgal biomass would occur in summer months due to the presence of fast-growing annual species which are absent in winter months). Re-exposure of hardbottom may likely occur due to high-energy dynamics of the area and downdrift and cross shore erosion of the fill material after equilibration of beach fill. Worm rock, turf, and macroalgae will likely recolonize these re-exposed hard substrates in the same fashion they colonize any previously buried hardbottom. Organisms with high recruitment capabilities dominate the nearshore hardbottom community; coverage and re-exposure of hardbottom substrate is a common occurrence in the project area. Potential impacts by burial are considered minor. The 1.08 acres that the project will permanently bury (as defined for regulatory purposes of evaluating impact and mitigation — but likely re-exposed over time) represents approximately 10% of the total approximate 10.4 acres of total hardbottom in and immediately adjacent to the project ETOF area, and a much smaller fraction of this habitat along the shoreline of Hutchinson Island. Therefore, burial is unlikely to affect the nearshore food web within the general project area adversely.

Alteration of Exposed Nearshore Hardbottom (Pipeline Placement)

Pipeline placement impacts to nearshore hardbottom from the proposed project depend on the placement location, size, and duration of sand delivery pipelines within the project area. The northernmost pipeline corridor (approximately at R-89.5) contains variable presence of hardbottom and partially-exposed hardbottom, but no practicable alternative (i.e., other route that would result in lesser impact) appears to be feasible for the north Project segment. The remaining four (4) proposed pipeline corridors (R-100, R-104, R-108, R-114) consist almost completely of sand and shell hash, with some interspersed small expanses of hardbottom or partially-exposed hardbottom. This small expanse provided little biotic cover and may be an area of ephemeral hardbottom exposure (CSA 2010a). Proposed corridors are approximatley 50 ft. wide. Permit requirements will include both pre- and post-construction hardbottom surveys to re-assess the pipeline corridors for hardbottom impacts. Due to the ephemeral nature of exposed hardbottom in the area, re-exposure of hardbottom in pipeline corridors currently delineated as sand bottom may occur. Assuming the placement of support-collars along the pipeline to raise it above the bottom in hardbottom areas, limited potential impacts to hardbottom would occur due to shading of benthos immediately under the pipeline, crushing of biota beneath the support-collars, and accidental collateral damage to hardbottom impacted by pipeline placement/removal equipment. Shading would have the greatest impact on photosynthetic organisms (e.g., macroalgae). Potential impacts by shading are considered minor as microalgae recolonizes quickly. Accidental collateral damage to hardbottom by pipeline placement and/or removal activities could result in localized crushing of hardbottom and/or associated epibiota. However, implementation of proper design and BMPs should reduce the magnitude and extent of impact resulting from project activities; therefore, potential impacts from pipeline placement/removal activities are considered minor and unlikely to affect the nearshore hardbottom within the project area adversely.

Turbidity

Several activities during construction will affect water quality. Sand placement on the beach face, where the main source of water quality impacts to nearshore hardbottom is, will produce turbidity at the beach sand placement site and adjacent waters. Impacts to nearshore hardbottom from turbidity depend on sediment grain size and duration of pumping activities. Finer sediments will have a longer suspension time compared with coarser sediments. Increased turbidity in nearshore waters would result in temporary shading of photosynthetic organisms (e.g., macroalgae), siltation of sessile organisms, and potentially cause interference to suspension feeders; however, given the anticipated relatively short duration of construction activity, the potential impacts from turbidity are considered minor.

4.4.2. BEACH FILL WITH NO IMPACT TO EXISTING HARDBOTTOM

No impacts to existing nearshore hardbottom would occur for the Beach Fill with the No Impact to Existing Hardbottom alternative.

4.4.3. BEACH FILL TO RESTORE THE 1972 BEACH AND DUNE

IPFs associated with the Beach Fill to Restore the 1972 Beach and Dune that may potentially affect nearshore hardbottom include

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during and subsequent to nourishment activities
- Alteration of exposed nearshore hardbottom and associated epibenthos resulting from the sand delivery pipelines
- Turbidity

The Beach Fill to Restore the 1972 Beach and Dune (1972 Design) alternative would produce less overall quantifiable impacts to exposed hardbottom substrate and associated epibiota because this alternative would cover a smaller area of hardbottom, 0.14 acres, than the Applicant's preferred plan. Impacts to nearshore hardbottom associated with all other IPFs would be similar to the Applicant's preferred plan.

4.4.4. BEACH FILL TO RESTORE THE 1972 DUNE WITH A 70-FOOT BERM

IPFs associated with the Beach Fill to Restore the 1972 Dune with a 70-Foot Berm that may potentially affect nearshore hardbottom include

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during and subsequent to nourishment activities

- Alteration of exposed nearshore hardbottom and associated epibenthos resulting from the sand delivery pipelines
- Turbidity

Compared to the Applicant's preferred plan, the Beach Fill to Restore the 1972 Dune with a 70-Foot Berm alternative would produce greater impacts (1.34 acres of hardbottom burial compared to 1.08 acres for the Applicant's preferred plan). However, relative to the total available habitat in the general project area, impacts to nearshore hardbottom associated with all other IPFs would be similar to the Applicant's preferred plan.

4.4.5. SOUTH SEGMENT BEACH AND DUNE RESTORATION; NORTH SEGMENT DUNE RESTORATION ONLY (NORTH SEGMENT DUNE RESTORATION ONLY)

IPFs associated with the North Segment Dune Restoration Only alternative that may potentially affect nearshore hardbottom include:

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during and subsequent to nourishment activities
- Alteration of exposed nearshore hardbottom and associated epibenthos resulting from the sand delivery pipelines
- Turbidity

The North Segment Dune Restoration Only alternative would create direct impacts only along the south segment resulting in less impact to exposed nearshore hardbottom (0.07 acres) and associated epibenthos than the Applicant's preferred plan (1.08. acres of hardbottom impact). Initial project implementation would not impact the often discontinuous, low- to medium-relief nearshore hardbottom including worm rock along the north project segment. However, modeling has shown that in the long term the sand placed on the south segment would spread into the area north of the south segment and potentially bury additional nearshore hardbottom areas. This alternative would create the same turbidity from dredging and pumping equipment impacts as the Applicant's preferred plan, except that the impact would occur only along the south segment.

4.4.6. BEACH AND DUNE RESTORATION WITH T-HEAD GROINS

IPFs associated with the Beach and Dune Restoration with T-Head Groins alternative that may potentially affect nearshore hardbottom include

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos from T-head groin construction activities
- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during subsequent to nourishment activities
- Alteration of exposed nearshore hardbottom and associated epibenthos resulting from the sand delivery pipelines from subsequent nourishment activities

- Turbidity

Compared to the Applicant's preferred plan, the Beach and Dune Restoration with T-Head Groins alternative would produce slightly more impact (1.13 acres of hardbottom burial compared to 1.08 acres for the Applicant's preferred plan) to the exposed nearshore hardbottom and associated epibenthos. The T-head groins would rest on some portion of hardbottom that would be lost indefinitely. However, depending on the construction material, the T-head groins may colonize and create new, but different hardbottom habitat that could be used for foraging and refuge. The 1.13 acres of impact does not include any potential impacts to hardbottom offshore of the downdrift areas anticipated to require nourishment. However, this is still a relatively small percentage of available hardbottom in the general project area.

Impacts to nearshore hardbottom associated with all other IPFs would be similar to those of the Applicant's preferred plan. However, additional impacts (e.g., turbidity, burial of exposed nearshore hard substrate) of nearshore habitats in downdrift areas could occur at a later date as a consequence of nourishment of downdrift areas intended to offset indirect impacts of the groin field.

4.4.7. NO-ACTION (STATUS QUO)

There are no IPFs associated with the No Action alternative potentially impacting nearshore hardbottom; therefore, no impacts would be expected.

4.5. FISH AND WILDLIFE RESOURCES

4.5.1. BEACH FILL TO RESTORE THE 1972 DUNE WITH A 35-FOOT BERM (APPLICANT'S PREFERRED PLAN)

IPFs associated with the Applicant's preferred plan that may potentially affect fish and wildlife includes

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during and subsequent to nourishment activities
- Disturbance of the sand bottom habitats and associated macroinfauna of the shoal borrow area and beach fill sites during nourishment activities
- Modification of the St. Lucie Shoal feature
- Turbidity
- Underwater noise and vibration from dredging activities
- Construction noise

<u>Alteration (Burial) of Exposed Nearshore Hardbottom</u>

The loss of this nearshore hardbottom habitat will result in impacts to the young stages of several reef fish species that use the nearshore hardbottom habitat. Nearshore hardbottom is an important component of the cross-shelf developmental pathways used by many reef species (Lindeman et al., 2000). The extent of the impact will depend on the size and longevity of buried nearshore hardbottom within the project area. This alternative is expected to displace juvenile fishes (i.e., prevent from using these impacted areas) as long as the associated epiflora, epifauna, and seafloor structure are covered. Complete burial would preclude reef species from feeding on the associated flora and fauna that use the nearshore hardbottom structure, thus disturbing the nearshore food-web dynamics. Recolonization of re-exposed hard substrates by worm rock and turf and macroalgae is probable as these organisms have high recruitment capability; coverage and re-exposure of hardbottom substrate is a common occurrence in the project area. The impacted area, 1.08 acres, represents a minor portion of the total habitat available for use along the coast of St. Lucie County, the impact is considered minor. The Applicant proposes mitigation to offset the impacts and, therefore, unlikely to affect the reef fish assemblages within the project area adversely.

Disturbance of Sand bottom Habitats

Dredging activities within the shoal borrow area and beach fill sites will impact the demersal and pelagic fish species, macrofaunal invertebrates, and infaunal benthic invertebrates. The potential disturbances to the sand bottom habitats include anchoring of the hopper barge during pump out activities, vibrations caused from the pump out activities, and placement of the pump out and conveyance pipes. Injuries to infaunal invertebrates and any motile macrobenthic invertebrate species will most likely occur during entrainment as part of the dredging and sand pumping operations. Some benthic infaunal invertebrates will survive and recolonize parts of the submerged beach fill area but any portion exposed on the new beach berm will not survive nourishment activity.

Greene (2002) summarized a number of studies of benthic invertebrate recovery rates. These studies show that benthic invertebrate communities' recovery rates can last as short as 2 weeks but often with an assemblage dissimilar to the preconstruction infaunal community composition. Recovery of organisms in soft-sediments typically occurs through larval transport and post-settlement life-stages (juveniles and adults) and varies with the season, habitat, and the species' life history characteristics. Recovery of the populations typically occurs 2–7 months after nourishment, given that organisms living in the high-energy beach environment, especially the intertidal area, are better adapted to disturbances (Atlantic States Marine Fisheries Commission 2002). Active dredging operations during project activities will displace motile macrobenthic invertebrates and especially demersal and pelagic fish species that use the soft bottom habitats (shoal areas and beach fill areas) unless these groups avoid the dredging areas. Dredging activities, once they begin, will restrict motile macrobenthic invertebrates and demersal/pelagic fishes from feeding on the associated infauna and flora that use the soft bottom habitat, thus disturbing the food-web dynamics related to these areas.

Because the temporal duration of the Applicant's preferred plan is short and the soft bottom infaunal invertebrate assemblage recovers relatively rapidly, impacts of short duration to soft bottom assemblages within the borrow site and surf zone and within and near the hardbottom habitats are considered minor and unlikely to adversely affect the soft bottom infaunal invertebrate assemblages within the sand bottom areas of the project area.

Modification of the St. Lucie Shoal Feature

Part of the Applicant's preferred plan calls for the removal of approximately 610,000 cubic yards of sand from the St. Lucie Shoal to provide sand for the initial nourishment activity. Offshore sand shoal habitats have been shown to provide fundamental ecological functions for demersal/pelagic fish species and motile macrobenthic invertebrates that include categories of spawning, shelter, or foraging. Offshore shoal habitats have been identified as important benthic habitats along the eastern U.S. and South Florida. Vasslides and Able (2008) found the richest fish assemblages at study sites off the coast of southern New Jersey associated with sand ridges in the 9-14m depth range. Recent studies by Gilmore (2009) have determined that as many as 200 species of fish use sand shoal habitats within their life-cycle, particularly during their cross-shelf migration, which is an important phase to the demersal reef fish population. These shoal habitats also function as aggregating points for small pelagic fishes, important prey for numerous managed species, particularly from the coastal pelagic and highly migratory groups. Modification of the St. Lucie Shoal feature could impact the demersal/pelagic fish and invertebrate assemblages that use this feature. Depending on the dredging design and execution, this action could alter this shoal structure permanently and affect the local ecological processes occurring at this location.

The dredging design avoids and preserves the highest areas of the shoal, as recommended by Diaz et al. (2003) and CSA International et al. (2009) to retain refuge areas for shoal fauna. The implementation of this mitigative approach to dredging should reduce the potential effects to the demersal/pelagic fish assemblages. In addition, borrow pits are known to attract numerous fishes and have also been known to provide resting places for sea turtles (Spring, K. and D. Snyder, CSA International, personal observations). Slacum et al. (2006, 2010) have indicated that for similar sand shoal habitats in the mid-Atlantic bight off the coasts of Maryland and Delaware, winter dredging may provide the least impactful period for dredging as that period includes the lowest use of the habitat by finfishes and invertebrates. Diaz et al. (2004) characterized seasonal changes in invertebrate fauna, concluding that appropriate project timing and engineering could lessen impacts on fishes by reducing stress on crustaceans that serve as primary prey items. The proposed project (and future projects) will dredge from November through April due to turtle nesting activity on project beaches. Thus the dredging period may also minimize potential impacts on shoal resources if the site exhibits similar biological cycles to those described in recent literature. Scott (2007), studying benthic communities of sand shoals off Cape May, New Jersey, concluded that continued dredging of the study area had not resulted in impacts to benthic taxa, abundance, or biomass. Based on differences in benthic assemblages in dredged and non-dredged areas, Scott and Burton (2005) concluded that "developing dredging plans for beach replenishment activities to limit the creation of dredge pits over at least 10 feet depth could reduce the chances of causing changes in benthic community, bottom sediment and water quality parameters detected in this study." They found no significant differences in the finfish communities associated with the study sites and stated, "since the fish community did not display an impact, the change in water quality and the benthic community observed in this study may have little impact on higher living resources." As the proposed dredging will extend a maximum of 10 feet below the original surface, the project appears to minimize impacts to benthic communities and finfish, at least as far as is currently known.

In a draft report under review by BOEMRE, Dibajnia and Nairn (2010) summarized field investigations and modeling studies intended to recommend offshore dredging guidelines to protect and maintain the integrity of ridge and shoal found on the OCS. They found that for shoals less than 30 meters deep, after dredging, a shoal reforms itself with the remaining (smaller) volume. They concluded, “there was no indication that there exists a critical threshold for dredging that once crossed, ridge and shoal features may deflate, losing their morphologic integrity.”

Given the implementation of BMPs in the design of the shoal’s dredging profile to help minimize the shoal impacts, including maintaining a refuge patch, the potential impacts from the modification to the shoal are considered moderate and, therefore, unlikely to affect adversely the demersal/pelagic fish and invertebrate assemblages using the shoal for extended periods.

Turbidity

Several activities during construction will affect water quality. The main source of water quality impacts — borrow area dredging and sand placement on the beach face — will produce turbidity at the borrow site and along the shoreline. Even if it does not kill fish, turbidity has been shown to have negative impacts during extreme natural events (Robins 1957). The nearshore hardbottom fish assemblages will most likely avoid any extreme turbidity conditions. Implementation of proper design and BMPs should reduce the magnitude and extent of impact resulting from project activities, which are of limited extent and short duration. Thus, potential impacts on the demersal hardbottom fish assemblages are considered short in duration (i.e., minor) and therefore unlikely to affect adversely fishes within the project area. Also due to the limited extent and short duration of the reduced water clarity, potential impacts on marine mammals and other wildlife that may use the project area are considered negligible and, therefore, unlikely to affect adversely the marine mammals and other wildlife within the project area.

Underwater Noise and Vibration from Dredging Activities

In general, the expected short-term sources and levels of underwater noise and vibration generated during a dredging project such as proposed should cause only negligible impacts on marine mammals, fish, and other wildlife present in the project area. Wildlife that may visit the project area during the construction period are likely to move away from or avoid disturbance caused by construction activities. These temporary avoidance behaviors are expected to incur negligible impacts on wildlife and, therefore, are unlikely to affect adversely the wildlife within the project area.

Construction Noise

In general, the sources and noise generated during the project construction activities will include temporary sources of noise and would result in short-term, minor, adverse effects to shorebirds and seabirds in the vicinity of both the beach fill and borrow area sites. This noise has the potential to impact terrestrial biological resources such as shorebirds and seabirds. Shorebirds and seabirds that may visit the project area during the construction period are likely to move away from or avoid disturbance caused by construction activities. These temporary avoidance behaviors are expected to incur negligible impacts and, therefore, are unlikely to affect adversely the wildlife within the project area.

4.5.2. BEACH FILL WITH NO IMPACT TO EXISTING HARDBOTTOM

IPFs associated with the Beach Fill with No Impact to Existing Hardbottom alternative that may potentially affect fish and wildlife include

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during and subsequent to nourishment activities
- Disturbance of the sand bottom habitats and associated macroinfauna of the shoal borrow area and beach fill sites during nourishment activities
- Modification of the St. Lucie Shoal feature
- Turbidity
- Underwater noise and vibration from dredging activities

Alteration (Burial) of Exposed Nearshore Hardbottom

The Beach Fill with No Impact to Existing Hardbottom alternative would have negligible impacts to hardbottom habitat because it would bury no hardbottom.

Disturbance of the Sand Bottom Habitats

Compared to the Applicant's preferred plan, the Beach Fill with No Impact to Existing Hardbottom alternative would have less impact on fish and macrobenthic invertebrate assemblages that use soft bottom habitats because this alternative would require less fill material.

Modification of the St. Lucie Shoal Feature

Compared to the Applicant's preferred plan, the Beach Fill with No Impact to Existing Hardbottom alternative would have less impact on fish and macrobenthic invertebrate assemblages, because this alternative would require removal of less fill material from the St. Lucie Shoal borrow area.

Turbidity

Compared to the Applicant's preferred plan, the Beach Fill with No Impact to Existing Hardbottom alternative would have less Impact on fish, macrobenthic invertebrate assemblages, and other wildlife for Applicant's preferred plan in regards to turbidity because this alternative would require removal of less fill material from the St. Lucie Shoal borrow area and require less material for the beach fill.

Underwater Noise and Vibration from Dredging Activities

The Beach Fill with No Impact to Existing Hardbottom alternative would have the same impacts to fish and other wildlife in the project area from noise and vibration from dredging activities as the Applicant's preferred plan.

4.5.3. BEACH FILL TO RESTORE THE 1972 BEACH AND DUNE

IPFs associated with the Beach Fill to Restore the 1972 Beach and Dune (1972 Design) alternative that may potentially affect fish and wildlife includes:

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during and subsequent to nourishment activities
- Disturbance of the sand bottom habitats and associated macroinfauna of the shoal borrow area and beach fill sites during nourishment activities
- Modification of the St. Lucie Shoal feature
- Turbidity
- Underwater noise and vibration from dredging activities

Compared to the Applicant's preferred plan, the Beach Fill to Restore the 1972 Beach and Dune (1972 Design) alternative would have less impact to fish, macroinvertebrate benthic assemblage, and other wildlife for for all associated IPFs, because this alternative would bury about 0.14 acres of hardbottom. Because this alternative would require less sand than the Applicant's preferred plan, dredging would involve less shoal habitat disturbance and generate less turbidity at the borrow site and beach fill area. A shorter construction duration would result in a shorter duration of underwater noise and vibration from construction activities.

4.5.4. BEACH FILL TO RESTORE THE 1972 DUNE WITH A 70-FOOT BERM

IPFs associated with the Beach Fill to Restore the 1972 Dune with a 70-Foot Berm alternative that may potentially affect fish and wildlife includes:

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during and subsequent to nourishment activities
- Disturbance of the sand bottom habitats and associated macroinfauna of the shoal borrow area and beach fill sites during nourishment activities
- Modification of the St. Lucie Shoal feature
- Turbidity
- Underwater noise and vibration from dredging activities

Compared to the Applicant's preferred plan, the Beach Fill to Restore the 1972 Dune with a 70-Foot Berm alternative would have greater impact to fish, macroinvertebrate benthic assemblages, and other wildlife for all IPFs. This alternative would impact 1.34 acres of hardbottom, a 0.26-acre increase compared to the Applicant's preferred plan. This increase in hardbottom burial would result in greater impact to the demersal/pelagic fish and macrobenthic invertebrate assemblage due to the greater surface area covered, and longer period of elevated turbidity within the beach fill area (resulting from the longer construction period). Impacts within the shoal habitat would also increase because of the increased volume of sand removed from the borrow area. The extended construction duration would result in longer duration of construction-generated underwater noise and vibration.

4.5.5. SOUTH SEGMENT BEACH AND DUNE RESTORATION; NORTH SEGMENT DUNE RESTORATION ONLY (NORTH SEGMENT DUNE RESTORATION ONLY)

IPFs associated with the North Segment Dune Restoration Only alternative that may potentially affect fish and wildlife include:

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during and subsequent to nourishment activities
- Disturbance of the sand bottom habitats and associated macroinfauna of the shoal borrow area and beach fill sites during nourishment activities
- Modification of the St. Lucie Shoal feature
- Turbidity
- Underwater noise and vibration from dredging activities
- Construction noise

Compared to the Applicant's preferred plan, the North Segment Dune Restoration Only alternative would have less impact to fish, macroinvertebrate benthic assemblages, and other wildlife for all IPFs as offshore direct impacts would only occur along the south segment. This alternative would impact 0.07 acres of hardbottom, a 1.01-acre decrease compared to the Applicant's preferred plan. This decrease in hardbottom burial would result in less impact to the demersal/pelagic fish and macrobenthic invertebrate assemblage due to the decreased surface area covered, and shorter period of elevated turbidity within the beach fill area in only the south segment. However, modeling has shown that in the long term the sand placed on the south segment would spread into the area north of the south segment and potentially bury additional nearshore hardbottom areas. Direct impacts to fish and offshore wildlife would only occur in the nearshore of the south segment.

Impacts within the offshore shoal habitat would also decrease because of the decreased volume of sand removed from the borrow area. The shorter offshore construction duration would result in shorter duration of construction and underwater noise and vibration.

4.5.6. BEACH AND DUNE RESTORTATION WITH T-HEAD GROINS

IPFs associated with the Beach and Dune Restoration with T-Head Groins alternative that may potentially affect fish and wildlife include:

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos from T-head groin construction activities
- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during subsequent nourishment activities
- Disturbance of the sand bottom habitats and associated macroinfauna of the shoal borrow area and beach fill sites during subsequent nourishment activities
- Modification of the St. Lucie Shoal feature
- Turbidity
- Underwater noise and vibration from construction and subsequent dredging activities

Compared to the Applicant's preferred plan, the Beach and Dune Restoration with T-Head Groins alternative would have a slightly greater impact to fish, macroinvertebrate benthic assemblages, and other wildlife for all IPFs. This alternative would impact 1.13 acres of hardbottom, a 0.05-acre increase compared to the Applicant's preferred plan. This increase in hardbottom burial would result in slightly greater impact to the demersal/pelagic fish and macrobenthic invertebrate assemblage due to the greater surface area covered, and elevated turbidity within construction area resulting from placement of the T-head groins. However, additional habitat for demersal/pelagic fish would also be created by the construction of the T-head groins.

The 1.13 acres of impact does not include any potential impacts to hardbottom offshore of the downdrift areas. The downdrift beaches are anticipated to require nourishment at a future time. Additional impacts (e.g., turbidity, underwater noise, burial of exposed nearshore hard substrate, modifications to the shoal feature) from the subsequent nourishment of downdrift areas would occur during that nourishment activity.

4.5.7. NO-ACTION (STATUS QUO)

The No Action alternative has no associated IPFs that may potentially impact fish and wildlife; therefore, no impacts would be expected.

4.6. ESSENTIAL FISH HABITAT

4.6.1. BEACH FILL TO RESTORE THE 1972 DUNE WITH A 35-FOOT BERM (APPLICANT'S PREFERRED PLAN)

IPFs associated with the Applicant's preferred plan that may potentially affect EFH include

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during and subsequent to nourishment activities
- Disturbance of the sand bottom habitats and associated macroinfauna of the shoal borrow area and beach fill sites during nourishment activities
- Modification of the St. Lucie Shoal feature
- Turbidity

Alteration (Burial) of Exposed Nearshore Hardbottom

Impacts to the live/hardbottom EFH from the Applicant's preferred plan will occur through burial of 1.08 acres of live/hardbottom habitat. Live/hardbottom habitat provides an important nursery and refuge habitat for the young stages of several fish species within the SAFMC Reef Fishes and Spiny Lobster Management Units. Nearshore hardbottom is an important component of the cross-shelf developmental pathways traversed by many reef species (Lindeman et al. 2000). The extent of the impact will depend on the size and longevity of buried nearshore hardbottom within the project area. It is expected that juvenile fishes will be displaced (i.e., prevented from utilizing these impacted areas) as long as the associated epiflora, epifauna, and seafloor hardbottom structure are covered. Complete burial will preclude reef species from feeding on the associated flora and fauna that use the nearshore hardbottom reef structure, thus disturbing the nearshore food-web dynamics; however, the anticipated burial area, 1.08 acres, is a small percentage of the total area available for use. Considered minor, this impact is unlikely to affect adversely the reef fish assemblages within the project area.

Disturbance of the Sand Bottom Habitats

Members of the penaeid shrimp and red drum EFH management groups use soft bottom habitats contiguous with the surf zone and nearshore hardbottom as forage or shelter habitats. Spiny lobsters use soft bottom habitats contiguous with the nearshore hardbottom as foraging areas. The potential disturbances to the sand bottom habitats include anchoring of the hopper barge during pump out activities, vibrations caused from the pump out activities, and placement of the pump out and conveyance pipes. Given the short temporal duration of the Applicant's preferred plan and the relatively rapid recovery of soft bottom infaunal invertebrate assemblages (forage habitat), relatively minor impacts to the EFH within nearshore beach fill sites are expected and therefore unlikely to affect adversely the soft bottom EFH within the project area.

Modification of the St. Lucie Shoal Feature

The Applicant's preferred plan, which includes removal of approximately 610,034 cubic yards of sand from the St. Lucie Shoal, would alter the local bathymetric profile in that area. Sand shoals were identified as EFH for coastal pelagic species and some highly migratory species, particularly coastal sharks. In addition, offshore sand shoal habitats have been shown to provide fundamental ecological functions for demersal/pelagic fish species and motile macrobenthic invertebrates that include categories of spawning, shelter, or foraging (CSA International et al. 2009). Recent studies (Gilmore 2009) have determined that 200 fish species use the sand shoal habitats along southeast Florida. Gilmore (2009) postulates that the shoal habitats are an intermediate habitat integrated in the cross-shelf migration used by many EFH managed groups. These shoal habitats also function as aggregation areas for small pelagic fishes, important prey for the coastal pelagic fish, dolphin and wahoo, and highly migratory species groups.

Removal of or modification of the St. Lucie Shoal feature could impact the EFH for multiple SAFMC-managed species groups that use this feature. This action might conceivably alter the shoal structure and change the fundamental ecological processes within and near this feature. In a draft report under review by BOEMRE, Dibajnia and Nairn (2010) summarized field investigations and modeling studies intended to recommend offshore dredging guidelines to protect and maintain the integrity of ridge and shoal found on the OCS. They found that for shoals less than 30 meters deep, after dredging, a shoal reforms itself with the remaining (smaller) volume. They concluded, “there was no indication that there exists a critical threshold for dredging that once crossed, ridge and shoal features may deflate, losing their morphologic integrity.”

The Applicant has included BMPs, including maintaining a refuge patch, in the shoal’s dredging profile design to help minimize shoal impacts,. The dredging design avoids and preserves the highest areas of the shoal, as recommended by Diaz et al. (2003) and CSA International et al. (2009) to retain refuge areas for shoal fauna. The implementation of this mitigative approach to dredging would reduce the potential effects to the demersal/pelagic fish assemblages. In addition, borrow pits are known to attract numerous fishes and have also been known to provide resting places for sea turtles (Spring, K. and D. Snyder, CSA International, personal observations). Thus, potential impacts from shoal modification are considered minor and, therefore, unlikely to adversely affect the demersal/pelagic fish using the shoal for extended periods.

Dredging activities within the shoal borrow area may also entrain multiple SAFMC-managed species groups, both fish and invertebrates, including the penaeid shrimp, spiny lobster, and red drum species group. Therefore, with the potential to permanently alter the shoal structure and change the fundamental ecological processes of the feature as well as the potential impact from the entrainment of managed species, minor to moderate impact from shoal dredging is expected and, therefore, unlikely to affect adversely the EFH for coastal pelagic fishes, dolphin and wahoo, and highly migratory species groups.

Turbidity

Several activities during construction will affect water quality. The main source of water quality impacts is borrow area dredging and sand placement within the beach fill sites. These activities will produce increased turbidity levels in both areas. Turbidity has been shown to negatively impact, if not cause fish mortality during extreme natural events of increased turbidity (Robins 1957). The nearshore reef fish assemblages will most likely avoid any extreme turbidity conditions. Due to the limited extent and short duration of the reduced water clarity, along with implementation of BMPs and proper design, relatively minor impacts are expected and, therefore, unlikely to affect adversely EFH within the project area.

4.6.2. BEACH FILL WITH NO IMPACT TO EXISTING HARDBOTTOM

IPFs associated with the Beach Fill with No Impact to Existing Hardbottom alternative potentially impacting EFH include

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during and subsequent to nourishment activities
- Disturbance of the sand bottom habitats and associated macroinfauna of the shoal borrow area and beach fill sites during nourishment activities
- Modification of the St. Lucie Shoal feature
- Turbidity

Alteration (Burial) of Exposed Nearshore Hardbottom

No expected impacts to EFH will occur due to the Beach Fill with No Impact to Existing Hardbottom alternative, because this alternative is not expected to bury any hardbottom habitat.

Disturbance of the Sand Bottom Habitats

Because the Beach Fill with No Impact to Existing Hardbottom alternative would require less fill than the Proposed Action, fewer impacts from disturbance of the sand bottom habitat to the penaeid shrimp, spiny lobster, and red drum species EFH for the Beach Fill would occur.

Modification of the St. Lucie Shoal feature

Compared to the Applicant's preferred plan, the Beach Fill with No Impact to Existing Hardbottom alternative would result in fewer impacts from modification of the shoal topography to EFH for coastal pelagic fishes, dolphin and wahoo, and highly migratory species groups, because this alternative requires less fill material removal from the St. Lucie Shoal borrow area.

Turbidity

Compared to the Applicant's preferred plan, the Beach Fill with No Impact to Existing Hardbottom alternative would produce fewer impacts related to EFH to because this alternative would remove less fill material for beach fill operations and thus create less turbidity.

4.6.3. BEACH FILL TO RESTORE THE 1972 BEACH AND DUNE

IPFs associated with the Beach Fill to Restore the 1972 Beach and Dune (1972 Design) alternative potentially impacting EFH include

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during and subsequent to nourishment activities
- Disturbance of the sand bottom habitats and associated macroinfauna of the shoal borrow area and beach fill sites during nourishment activities
- Modification of the St. Lucie Shoal feature
- Turbidity

Compared to the Applicant's preferred plan, the Beach Fill to Restore the 1972 Beach and Dune (1972 Design) alternative would produce fewer impacts to the EFH for all of the SAFMC-managed species for all IPFs. As anticipated, this alternative would bury 0.14 acre of hardbottom and remove less fill material, which would disturb less shoal habitat and generate less turbidity at the borrow site and beach fill area.

4.6.4. BEACH FILL TO RESTORE THE 1972 DUNE WITH A 70-FOOT BERM

IPFs associated with the Beach Fill to Restore the 1972 Dune with a 70-Foot Berm alternative that may potentially impact EFH include

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during and subsequent to nourishment activities
- Disturbance of the sand bottom habitats and associated macroinfauna of the shoal borrow area and beach fill sites during nourishment activities
- Modification of the St. Lucie Shoal feature
- Turbidity

Compared to the Applicant's preferred plan, the Beach Fill to Restore the 1972 Dune with a 70-Foot Berm alternative would increase impacts to EFH for the SAFMC-managed species for all IPFs. As anticipated, the Beach Fill to Restore the 1972 Dune with a 70-Foot Berm alternative would bury 1.34 acres of hardbottom, a 0.26-acre increase in the amount of hardbottom the Applicant's preferred plan would bury. This increase in hardbottom burial would result in greater impact to species from the Reef Fish Management Unit through the loss of hardbottom habitat. An increase in the temporal period for construction would occur, along with elevated turbidity within the borrow area and beach fill area. Impacts within the shoal habitat would also increase given the increased sand volumes removed from the St. Lucie Shoal borrow area. The increased sand dredging activity volume within the St. Lucie Shoal borrow area would result in increased impacts to EFH for the coastal pelagic fish, dolphin and wahoo, and highly migratory species groups.

4.6.5. SOUTH SEGMENT BEACH AND DUNE RESTORATION; NORTH SEGMENT DUNE RESTORATION ONLY (NORTH SEGMENT DUNE RESTORATION ONLY)

IPFs associated with the North Segment Dune Restoration Only alternative that may potentially impact EFH include

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during and subsequent to nourishment activities
- Disturbance of the sand bottom habitats and associated macroinfauna of the shoal borrow area and beach fill sites during nourishment activities
- Modification of the St. Lucie Shoal feature
- Turbidity

Compared to the Applicant's preferred plan, the North Segment Dune Restoration Only alternative would decrease direct impacts to EFH for the SAFMC-managed species for all IPFs. As anticipated, the North Segment Dune Restoration Only alternative would bury 0.07 acres of hardbottom, a 1.01-acre decrease in the amount of hardbottom impact compared to the impacts of the Applicant's preferred plan. The alternative would not impact the often discontinuous, low- to medium-relief nearshore hardbottom including worm rock along the north segment of the project. This decrease in hardbottom burial would result in less impact to species from the Reef Fish Management Unit through the loss of hardbottom habitat. However, modeling has shown that in the long term the sand placed on the south segment would spread into the area north of the south segment and potentially bury additional nearshore hardbottom areas. A decrease in the temporal period for construction would occur, along with elevated turbidity within the borrow area and beach fill area. Impacts within the shoal habitat would also decrease due to the decreased sand volumes removed from the St. Lucie Shoal borrow area. The decreased sand dredging activity volume within the St. Lucie Shoal borrow area would result in decreased impacts to EFH for the coastal pelagic fish, dolphin and wahoo, and highly migratory species groups.

4.6.6. BEACH AND DUNE RESTORATION WITH T-HEAD GROINS

IPFs associated with the Beach and Dune Restoration with T-Head Groins alternative that may potentially impact EFH include:

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos from T-head groin construction activities
- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during subsequent nourishment activities
- Disturbance of the sand bottom habitats and associated macroinfauna of the shoal borrow area and beach fill sites during subsequent nourishment activities
- Modification of the St. Lucie Shoal feature
- Turbidity

Compared to the Applicant's preferred plan, the Beach and Dune Restoration with T-Head Groins alternative would slightly increase impacts to EFH for the SAFMC-managed species for all IPFs. The Beach and Dune Restoration with T-Head Groins alternative would bury 1.13 acres of hardbottom, a 0.05-acre increase in the amount of hardbottom the Applicant's preferred plan would bury. This slight increase in hardbottom burial would result in slightly greater impact to species from the Reef Fish Management Unit through the loss of hardbottom habitat. However, additional habitat for demersal/pelagic fish would also be created by the construction of the T-head groins. The 1.13 acres of hardbottom impact does not include any potential impacts to hardbottom offshore of the downdrift areas that are anticipated to require nourishment at a later date.

Additional impacts similar to those of the Applicant's preferred plan (i.e., turbidity, burial of exposed nearshore hard substrate) would occur on downdrift beaches if indirect impacts of the groin fields required mitigation through subsequent nourishment of downdrift areas.

If sand for nourishment of downdrift areas impacted by the groin field was obtained from the St. Lucie Shoal, borrow area proposed for the project, additional direct impacts to that area would also occur. The additional sand dredging activity within the St. Lucie Shoal borrow area would result in EFH impacts similar to those of the Applicant's preferred plan for the coastal pelagic fish, dolphin and wahoo, and highly migratory species groups.

4.6.7. NO-ACTION (STATUS QUO)

No IPFs are associated with the No Action alternative potentially impacting the EFH for the SAFMC-managed species; therefore, no impacts would be expected.

4.7. OFFSHORE BORROW AREA RESOURCES

IPFs associated with the Applicant's preferred plan potentially impacting offshore borrow area resources include

- Disturbance of the shoal borrow area sand bottom habitat and associated macroinfauna during nourishment activities
- Modification of the St. Lucie Shoal feature
- Turbidity
- Underwater noise and vibration from dredging activities

Disturbance of the Shoal Borrow Area Sand Bottom Habitats

Dredging of the offshore borrow site will result in mechanical disturbance of the seabed. The proposed activity includes removal, suspension, and displacement of dredged material, which will alter the benthic environment and its associated infauna and epibiota, two important components of the food web for commercially and recreationally important fishes and invertebrates. Excavation of sediments from borrow sites will modify the existing topography of the shoal feature, exposing underlying sediments that can change the sediment structure and composition of the borrow site. These changes can lead to changes in benthic community composition.

Modification of the St. Lucie Shoal Feature

Benthic species' ability to perform life functions (e.g., burrowing, feeding, or settling as larvae) varies with sediment quality, and members of the current benthic community may or may not have the same success in the physical characteristics of the underlying sediment as in the existing sediment. A Literature Synopsis, conducted by the U.S. Geological Survey (USGS) in 2004, examined the recovery and/or re-colonization time of benthic communities. Studies found that recovery durations can range from three months to 2.5 years. Recovery of the original community composition has been suggested to potentially take a substantial amount of time, especially in sand mining areas used repeatedly. The literature review of infaunal density and species richness studies examining benthic composition of dredged shoals found no consistent pattern of faunal response to dredging (USGS, 2004). Given the short temporal duration of the Applicant's preferred plan and relatively rapid recovery of the soft bottom infaunal invertebrate assemblage, short duration impacts to soft bottom assemblages within the borrow site are expected. Therefore, these impacts are considered minor and unlikely to affect adversely the soft bottom infaunal invertebrate assemblages within the sand bottom areas of borrow site.

In addition, excavation alters the seabed topography, creating pits that that may refill rapidly or cause detrimental impacts to the benthic community for extended periods. In contrast, dredging can also create habitats different from the surrounding area, which could result in increased habitat complexity and biodiversity of the area. Studies have shown that some borrow areas located within highly depositional areas have a relatively short filling time, whereas other areas may take up to 12 years returning to pre-dredge topography (Wright 1977). In general, shallow dredging over large areas causes less change than smaller deep pits. Borrow pits excavated in small deep pits reduce current velocities at the bottom, which can cause the deposition of fine particulate matter and potentially create a biological assemblage much different in composition than the original (Hammer et al. 2005). This action could alter this shoal structure permanently and locally affect the seabed topography within the borrow site. However, these potential changes in the shoal structure may not cause long-term changes in the benthic community species abundance and richness but would most likely alter the community composition. BMPs implemented in the design of the dredging profile of the shoal will help minimize the impacts to the shoal, including maintaining a refuge patch. In addition, borrow pits are known to attract numerous fishes and have also been known to provide resting places for sea turtles (Spring, K. and D. Snyder, CSA International, personal observations). The potential impacts from the modification to the shoal are considered minor and, therefore, unlikely to affect adversely the benthic community for extended periods.

Turbidity

Increased turbidity levels would result from dredging sediments at the borrow area and from suspending fine grained fractions of the borrow material in the water column, which creates a visible, turbid plume in the water column. In addition, excess seawater, decanted and discharged overboard by the hopper dredge, will temporarily increase turbidity during construction. These turbid plumes can cause physical or behavior impacts to invertebrates, particularly sessile organisms on the nearshore hardbottom areas. If the borrow material contains only a small portion of fine grained materials, the turbidity should diminish rapidly and have little impact on organisms in the area; however, if the fine grained portion is high, the turbidity can remain for longer periods or, in some cases, persist over the long term. Preliminary geotechnical data indicate that the sands in Area A of the St. Lucie shoal contain less than 1.6% fines (Coastal Tech 2009: Appendix D: Geotechnical Analyses), and therefore, the impacts from turbidity are considered minor and unlikely to affect adversely the soft bottom infaunal invertebrate assemblages within the adjacent sand bottom areas.

Underwater Noise and Vibration from Dredging Activities

Potential effects of the elevated background noise levels caused by man-made noise to marine mammals include

- Limiting the detection by mammals of natural sounds
- Disturbing their normal behavior, resulting in possible displacement from areas
- Causing temporary or permanent reductions in hearing sensitivity

The potential effects depend on the type of marine mammal involved because different marine mammals have different hearing frequencies. The levels and types of ambient noise also strongly influence the potential area or zone of influence of a man-made sound. Clarke et al. (2005) characterized underwater sounds generated by bucket, hydraulic cutterhead, and hopper dredging operations, but have not reported the relationships between such noises and faunal behavioral changes associated with those noises. An animal's sensitivity to different sounds varies with frequency, and its response to a sound likely depends strongly on the presence and levels of sound in the frequency band or range of frequencies to which it is sensitive (Ports Corporation of Queensland 2005). Underwater noise can affect marine mammals (Richardson et al. 1995). However, the project does not involve any high energy sound sources that could cause temporary or permanent auditory damage. In general, the sources and levels of underwater noise and vibration generated during the project are expected to cause only minor impacts on marine mammals. The most likely impacts are temporary behavioral responses such as avoidance or altered diving or swimming behavior.

The Applicant's preferred plan includes part of the species' migratory route and as potential calving grounds during the winter months; however, these whales are rare to the project area. The humpback whale is rarely present within the vicinity of St. Lucie County during its spring/fall migration. Manatees would not likely occur in the offshore shoal area. Marine mammals would likely avoid areas where the dredge is operating. The project area is an extremely small area when compared to the overall waters used for The North Atlantic right whale uses migration and calving; therefore, the dredging activities may affect, but are unlikely to affect adversely, marine mammals in the project area.

Thomsen et al. (2009) studied the possible noise sensitivity of marine life off the coast of England. They found that dredging noises were intermediate to high-level noise (e.g., sonar and pile driving) and lower-level noise such as normal vessel traffic. They identified specific vertebrate and invertebrate species in their study area potentially impacted by dredging noises. However, they gave no indication that such noise had the potential for permanent adverse effects. They concluded that the main issues with dredging noise included the lack of information about the noise generated by dredging operations and the lack of any experimental study of potential impacts.

Compared to the Applicant's preferred plan, all other alternative would have similar impacts to the offshore borrow area resources for all IPFs to a greater or lesser degree based on the quantity of sediment dredged.

No IPFs are associated with the No Action alternative to offshore borrow area resources.

4.8. COASTAL BARRIER RESOURCES

The project area includes several areas within CBRS Unit P-11 (Hutchinson Island) which precludes federal expenditure of funds for a beach restoration project within those areas. In a May 27, 2009 letter from the FWS (FWS 2009) relative to a USACE request for a "consistency determination" under the Coastal Barrier Resources Act (CBRA), the USFWS determined that the project areas within CBRS Unit P-11 will not meet the exception criteria that allows "expenditure of Federal revenues" to renourish these areas. In the same letter, the FWS determined that because the majority of the land outside the excluded parcels of CBRS Unit P-11 is privately owned and not under any perpetual conservation designations, the renourishment of these beaches would encourage development on those parcels. Accordingly, with one exception, the sections of beach within the CBRA Unit P-11 were excluded from the project area. In spite of the federal funding conditions, the county decided to include this one exception — Dollman Park (R-101 – R-103) — of the CBRA shoreline as part of the project, because St. Lucie County recognized the need for fill in that location. Due to the exclusion of the majority of the beach section within CBRA Unit P-11, no negative impacts to the CBRS units are expected from this project.

The Applicant's preferred plan would protect adjacent coastal barrier resources by restoring valuable beach and dune habitat. Placement of approximately 610,000 cy of sand within the project area would contribute to the sand-sharing system and provide feeder benefits to adjacent shorelines.

4.9. WATER QUALITY

Implementing the Applicant's preferred plan would cause temporary increases in turbidity levels as a result of the dredging of sediments at the borrow area and placement of sediments on the beach. Turbidity results from the suspension in the water column of fine grained fractions of the borrow material, which creates a visible, turbid plume in the water column. This turbid plume can cause physical or behavior impacts to invertebrates, particularly sessile organisms on the nearshore hardbottom areas. If the borrow material contains only a small portion of fine grained materials, the turbidity should diminish rapidly and have little impact on organisms in the area; however, if the fine grained portion is high, the turbidity can linger for longer periods or, in some cases, persist long term. Preliminary geotechnical data indicates that the sands in Area A of the St. Lucie Shoal contain less than 1.6% fines (Coastal Tech 2009: Design Document, Appendix D: Geotechnical Analyses); therefore, the turbidity is anticipated to diminish rapidly. In addition, if the composition of the borrow material is sufficiently high in carbonates such as shell and coral fragments, turbidity can increase as the water can take on a "milky" appearance as the carbonate materials grind in the high energy surf zone into small clay-like particles. A composite sediment sample from Area A of the St. Lucie Shoal indicates a 78.4% carbonate content (Coastal Tech 2009: Design Document, Appendix D: Geotechnical Analyses), with less than 1% gravel (shell). This finding would indicat that only a very small portion (less than 1%) of the material would have the potential to grind up within the high energy surf zone creating a "milky" appearance to the water. Therefore, the impacts from turbidity are considered short-term and minor and unlikely to affect adversely the water quality within the borrow area, project area, and adjacent areas.

During project construction, turbidity monitoring will ensure that the project meets state water quality standards at the mixing zone boundary. Monitoring will occur at both the borrow area and at material placement locations. Background monitoring at the borrow material placement site will occur approximately 65 m from shore and 150 m up-current from the fill discharge or placement location. Compliance monitoring will occur no more than 65 m from shore within the densest portion of any visible turbidity plume, 150 m down current of the discharge point.

No IPFs are associated with the No Action alternative to water quality within the beach fill or borrow area.

4.10. HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

The Applicant's preferred plan would affect no known hazardous, toxic, or radioactive waste sites or producers in the project area. No impacts associated with the disturbances of such sites are anticipated from either the Applicant's preferred plan or No Action Alternative. The Applicant's preferred plan will not involve placement, use, or storage of hazardous and toxic materials in or near the project area. A potential for hydrocarbon spills exists with dredging and construction equipment in the area, but accident and spill prevention plans delineated in the contract specifications should prevent most spills. The responsible party will properly store all wastes and refuse generated by the project and remove them when project activities end.

4.11. AIR QUALITY

The short-term impacts from emissions by dredges and other construction equipment associated with the project would not significantly affect onshore or offshore air quality. Given the brief period of construction activity, exhaust emissions from vehicles, vessels, and construction equipment associated with the project would have a temporary and localized effect on air quality. Because offshore sea breezes would disperse pollutants, no long-term accumulation of particulates in the project area will occur. This project requires no air quality permits.

Taylor Engineering used project-specific parameters to prepare an air quality analysis to estimate emissions for the Applicant's preferred plan. The analysis included calculation of total project emissions of nitrogen oxides (NO_x), sulfur dioxide (SO_2), carbon monoxide (CO), volatile organic compounds (VOCs), and particulate matter (PM) less than 10 microns and less than 2.5 microns.

Power requirements, duration of operations, and emission factors for the various equipment types used in project construction provided the basis for estimates of air pollutant emissions resulting from construction of the Applicant's preferred plan.

The product of horsepower (hp) rating, activity rating factor (percent of total power), and operating time provided the estimate of project energy use. The energy use value multiplied by an engine-specific emission factor yielded emission estimates.

Operational data reported in the Martin County DEIS (USACE 2010) for a beach nourishment project of similar size immediately south of the proposed project area provided power requirements and duration for each phase of the proposed hopper dredging activity.

The hp rating of the dredge plant considered propulsion (3,500 hp), dredging (2,565 hp), pumping (2000 hp), and auxiliary (600 hp). Different rating or loading factors were used for dredging, propulsion, and pumping. The air quality analysis contains the following assumptions:

- Project would dredge 610,000 cubic yards.
- Dredging cycle time (dredging, travel to transfer point, pump-out, and return to dredge site, and idle time) would last 6 hours.
- Each dredging cycle would move on the order of 2,500 cubic yards of material, requiring approximately 293 loads to excavate enough material to place 610,000 cubic yards of sand on the beach.
- Dredging would last 73 days.
- Distance from dredge site to transfer point would span 3 miles.
- Placement and relocation of nearshore mooring buoys used during pump-out may involve up to two tender tugboats, a derrick barge two work barges, and pipeline hauler/crane.
- Construction would include moving the buoy (and the sub pipe) 5 times during the project; each move would require approximately 12 hours of machine operation.
- Crew/supply vessel operation would approach 4 hours per day.

The analysis assumed that all dredging, hopper transport, and crew/supply vessel activities occurred over state waters and at the placement site. The beach-fill-related estimates assumed the use of up to four bulldozers/pipeline movers and two trucks, each operating 80% of the time for the duration of the project.

Emission factors for the diesel engines on the hopper dredge, barge, and tugboats came from from EPA's *Compilation of Air Pollutant Emissions Factors, AP-42, Volume 1* (2002). Derived emission factors for tiered equipment used in beach construction came from NONROAD model (5a) estimates.

The Applicant's preferred plan may result in small, localized, and temporary increases in concentrations of NO_x, SO_2, CO, VOCs, and PM (**Table 4.11-1**). Because the project is located in an air quality attainment area, the EPA requires no preliminary air quality conformity assessment.

Emissions associated with the dredge plant would provide the largest contribution to the inventory. However, the total project emissions represent a minor percentage of the existing point and nonpoint and mobile source emissions in St. Lucie County (**Table 4.11-1**). Prevailing winds would quickly disperse any pollutant released into the atmosphere from the project area.

The No-Action alternative would have no impact on air quality.

Table 4.11-1. Estimated Emissions of the Applicant's Preferred Plan (tons per year)

Activity	Emissions (tons)					
	NO_x	SO_2	CO	VOC	$PM_{2.5}$	PM_{10}
Dredge Plant (Hopper)						
Dredging/Operation	11.1	0.2	2.6	0.3	0.2	0.2
Turning/Sail	23.4	0.4	5.4	0.6	0.4	0.4
Pump-out	10.8	0.2	2.5	0.3	0.2	0.2
Idle/Connect-Disconnnect	3.1	0.1	0.7	0.1	0.1	0.1
Supporting Offshore Activities	7.3	0.1	1.7	0.2	0.2	0.1
Beach Fill	5.6	1.0	2.6	0.4	0.4	0.4
Total Project Emissions	**61.3**	**2.0**	**15.4**	**1.9**	**1.4**	**1.4**
2002 Countywide Emissions Nonpoint + Mobile	9,509	1,661	70,230	12,636	1,480	6,646
2002 Countywide Emissions Point and Nonpoint + Mobile	10,037	1,681	70,777	14,162	1,551	6,743

St. Lucie County 2002 emissions from EPA National Emission Inventory http://www.epa.gov/air/data/

4.12. NOISE

Project construction activities would result in short-term minor adverse effects to the noise environment in the vicinity of both the beach fill and borrow area sites. Construction will include temporary sources of noise. This noise has the potential to adversely impact biological resources such as fishes, sea turtles, marine mammals, and seabirds as discussed above in **Sections 4.3** and **4.5**. Only minor and temporary impacts, however, are expected. As expected, noise generated from activities at the borrow area site would not affect noise-sensitive receptors onshore due to the distance from shore.

Proper maintenance of construction and dredging and pumping equipment would minimize the noise impacts and construction activities would occur for a short period.

Construction noise would have a short-term, minor effect on sound levels in the vicinity of the construction activities.

The No Action alternative would not result in noise impacts.

4.13. AESTHETIC RESOURCES

IPFs associated with the Applicant's preferred plan potentially impacting aesthetic resources include:

- Presence of construction equipment
- Noise
- Turbidity

The pipeline coming out of the water and along the beach, earthmoving equipment spreading sand along the beach, and associated construction activities will temporarily affect the aesthetics in the project area. Earth moving equipment used to distribute the sand will temporarily create visual disturbance as well as noise and exhaust fumes, which will decrease the overall aesthetic value in the immediate vicinity of the project activities. Earth moving equipment will operate from along the beach front to distribute the sand effectively after initial placement on the beach from the discharge pipes. Sand placement would cause short-term turbidity increases in the nearshore waters, resulting in a change in water color and clarity, and resulting in temporary minor impacts.

Analysis of grain size, color, and hue of the proposed borrow area sand area indicates that the dredged sand will correspond closely with the existing sand. With restoration of the currently eroded beaches, the overall aesthetic value within the project beach area will increase.

The viewshed within the proposed borrow area during project implementation will experience short-term impacts from the hopper dredge and supporting equipment operation during project implementation. However, noise generated from activities at the borrow area site, with the dredge located approximately 3 miles offshore, would not affect noise-sensitive receptors onshore and would result in short-term, negligible impact to the viewshed and aesthetics for residents in the project area. Therefore, the overall impacts are unlikely to affect adversely aesthetics within the project area.

With the No Action alternative, the aesthetic value of the beach will continue to diminish as the beachfront continues to erode and narrow. In addition, the potential for the construction of numerous emergency shoreline armoring structures and other stopgap measures that would very likely continue to narrow the beach would increase, diminishing the aesthetic value of the area and resulting in long-term, permanent impacts to the aesthetics of the area.

4.14. RECREATION RESOURCES

IPFs associated with the Applicant's preferred plan potentially impacting recreational resources include

- Limited and/or restricted access
- Turbidity

Recreational use of the beaches and coastal waters would temporarily decrease in the immediate vicinity of active nourishment and borrow dredging efforts. Temporary public safety restrictions would keep beachgoers and recreational users from the areas of active construction on the beach and at the borrow site. The active construction areas will shift along the project area beach; recreational users could access already-nourished areas. Increased turbidity and resulting decrease in visibility would reduce or eliminate scuba diving and snorkeling in the project construction zone and in the mixing zone down current of the project area beach, where temporary increased turbidity may occur. The project would not likely affect nearshore coastal boating and fishing, which could continue as usual during nourishment activities. Project implementation would result in overall short-term, negligible impacts to recreational opportunities because the project area is a small percentage of the total available area for recreational opportunities within St. Lucie County. Therefore, the overall impacts are unlikely to affect adversely recreation within the project area.

The Recreational Benefits Assessment conducted from 2007 to 2008 (Stronge 2008) surveyed beach users on south Hutchison Island in St. Lucie County from R-77 to the Martin/St. Lucie County line to determine the amount beach users would willingly pay during each visit to use the beach. Based on this amount that beach users would willingly pay, Stronge concluded that nourishment would add a recreational use benefit of $549,690 compared to the existing beach, resulting in a positive impact to recreation from project implementation.

With the No Action alternative, recreational opportunities would diminish over time on the beach area, as the beach would continue to erode and narrow, further degrading shorefront properties. Offshore recreational opportunities (e.g., fishing, snorkeling, or scuba diving) would not incur impacts.

4.15. NAVIGATION

Recreational and fishing boats comprise the majority of vessel traffic in the project vicinity. Although most of the traffic is concentrated within the Indian River Lagoon, Ft. Pierce Inlet, and St. Lucie Inlet, private and chartered fishing and excursion boats frequently visit nearshore and offshore reefs and shoals. Commercial vessel traffic is generally limited to those traveling to and from the Port of Ft. Pierce through Ft. Pierce Inlet. The proposed borrow area is located away from commercial shipping routes. Project construction would have a short-term, minor adverse impact on vessels in the project vicinity due to the presence of the dredging vessel and associated pipelines.

4.16. HISTORIC PROPERTIES

IPFs associated with the Applicant's preferred plan potentially impacting historic properties include

- Damage to historic or cultural resources

The final archaeological / cultural resources investigation report for the project area recommended a finding of no project effect on cultural resources listed, or eligible for listing, in the National Register of Historic Properties, or otherwise of historical, archaeological, or architectural value; and recommended no further investigation of the area. The Florida Department of State – Division of Historical Resources reviewed the survey report and, in a letter to the USACE on 15 April 2008 (**Appendix I**), concurred with the report findings and recommendations; therefore, no impacts to historic properties are anticipated.

Between September 2007 and June 2008, a remote sensing survey of borrow area 5 located offshore of Martin and St. Lucie Counties was conducted by SEARCH for the U.S. Army Corps of Engineers (USACE), Jacksonville District. For Coastal Tech, in December 2010, SEARCH conducted a remote sensing survey of the portion of borrow area 5 that was not previously investigated. SEARCH determined that the proposed activities within borrow area 5 will have no effect on cultural resources, listed, or eligible for listing and recommended no further investigation of the area. The Florida Department of State - Division of Historical Resources reviewed both reports and issued letters dated 4 September 2008 and 20 January 2011 concurring with the reports findings and recommendations.

No IPFs are associated with the No Action alternative for historic properties within the project area; therefore, no impacts would be expected.

4.17. SOCIOECONOMICS

Sand dredging activities will limit or restrict access to the St. Lucie Shoal borrow area habitat for recreational and commercial fishing. This reduction in access may temporarily impact local businesses that provide fuel, food, fishing equipment, and bait to private and commercial vessels that fish within the project shoal borrow area. However, the restricted access area represents a very small portion of the total area available for fishing in southern St. Lucie County. The short duration of the Applicant's preferred plan will result in the return of some fish species relatively rapidly after completion of dredging (CSA International 2009a). Increased recreational uses of the nourished beach after project completion will likely offset the short-term economic impacts from lost recreational and commercial fishing opportunities. Therefore, the proposed project is unlikely to affect adversely socioeconomics within the project area.

Storm damage reduction benefits include the dollar amounts of potential storm damage that the addition of beach extensions will prevent. **Table 4.17-1** summarizes the annual economic benefits associated with each alternative. The Applicant's preferred plan yields the greatest net primary benefit (Coastal Tech 2009: Design Document, Appendix C: Cost Benefit Analysis).

Table 4.17-1. Alternatives Benefits Summary

Alternative	Annual Benefits			Total	B/C Ratio	Net Primary Benefits
	Storm Damage Reduction Benefits	Land Loss Benefits	Recreational Benefits			
No-Action	--	--	--	--	--	--
No Impact to Hardbottom	$269,799	$451,895	--	$721,694	0.27	($1,991,926)
1972 Template	$348,115	$451,895	--	$800,010	0.21	($3,065,146)
35’ Berm	$1,964,066	$446,245	$549,690	$2,960,002	2.04	$960,934
70’ Berm	$2,557,388	$446,245	$1,756,869	$4,760,502	2.30	$937,424

Potential effects to socioeconomic resources in the project area due to continued erosion of existing beach (No-Action alternative) include increased potential of storm damages. These damages, all resulting from diminishing beach and nearshore areas, may include losses to buildings and land along the Atlantic coastline, losses in tourism and tax revenue to St. Lucie County, losses of recreational opportunities, and losses in jobs related to these activities.

4.18. PUBLIC SAFETY

As a public safety measure, beach and water-related recreation in the immediate vicinity of the discharge pipe would be prohibited during project construction. Likewise, water-related activities near the dredge site would also be prohibited during project construction. Recreational access to these areas would return to pre-construction conditions following completion of the project. Long-term effects are not anticipated. The No-Action Alternative would assume continued erosion, allowing the surf zone to advance landward, with the potential of adverse impacts to public safety due to storm damage.

4.19. ENERGY REQUIREMENTS AND CONSERVATION

Energy requirements for the proposed alternative would be limited to the fuel for the dredging and pumping equipment, labor transportation, and construction equipment associated with beach placement. The use of sand from the proposed borrow areas would require less energy expenditure than obtaining sand from any other distant source. The No-Action Alternative would allow erosion to continue, and may require greater energy expenditure of on-site preventative measures and post-storm clean-up in the event of a storm (USACE 1996).

4.20. NATURAL OR DEPLETABLE RESOURCES

No natural energy resources occur within the proposed project area. The sand shoal proposed as a source for beach fill is considered a depletable resource. Project dredging will reduce the quantity of shoal sand. The St. Lucie Shoal, currently proposed as the offshore borrow site, contains approximately 1.3 million cubic yards of beach compatible material (CPE 2006b). The sand shoals offshore of the project area include well-developed, shore-face connected, and isolated linear shoals with north-to-south orientation. These features, depositional in nature, exhibit varying degrees of morphological change in response to local hydrodynamic conditions. Sand shoals form as an irregularity on the seafloor and then grow in response to local coastal processes (waves, tides, currents). Ongoing formation results in a growing shoal. Shoals may also represent relic structures of past coastal processes no longer in action at a particular site.

Excavation of sediments from borrow sites exposes underlying sediments and can change the sediment structure and composition of the borrow site. This can lead to changed benthic community composition. Benthic species' ability to perform life functions (e.g. burrowing, feeding or settling as larvae) varies with sediment quality and members of the current benthic community may or may not have the same success in the physical characteristics of the new sediment as in the existing sediment. In addition, excavation alters the seabed topography, creating pits that that may refill rapidly or remain for extended periods. Studies have shown that some borrow areas located within highly depositional areas have a relatively short filling time, whereas other areas may take up to 12 years returning to pre-dredge topography. In general, shallow dredging over large areas causes less change than smaller deep pits. If borrow pits are excavated in small deep pits, current velocity is reduced at the bottom, which can cause the deposition of fine particulate matter and potentially create a biological assemblage much different in composition than the original (Hammer et al. 2005). These assemblages may not provide the same trophic support as the original benthic community. However, the project dredging design provides a maximum dredging depth of only 10 ft below the existing surface (a relatively shallow dredging template) and the dredge footprint comprises a very small portion of the total benthic habitat area. Predators on the benthic community will still have ample forage area after dredging ends. Therefore, the impacts are considered minor and not likely to adversely affect the soft bottom infaunal invertebrate assemblages within the sand bottom areas of borrow site. Structurally, however, dredging could alter this shoal structure permanently and locally affect the seabed topography within the borrow site. BMPs included in the design of the dredging profile of the shoal, including avoidance of dredging across the shoal and maintaining a refuge patch at the highest shoal elevations will help minimize the impacts to the shoal habitat. In addition, based on physical geological models of shoal formations, there does not appear to be a mechanism that supports the idea that structural integrity of a shoal feature will "deflate" or "unravel" when subject to repeated dredging events (CSA International et al. 2009), which has been suggested by Michel et al. (2001). Dibajnia and Nairn (2010) summarizing field and modeling studies of shoal behavior with dredging indicated that dependent upon dredging location, shoals will reform and retain existing original height after completion of dredging.

However, not all impacts from dredge pits are detrimental. Borrow pits are known to attract numerous fishes and have also been known to provide resting places for sea turtles (Spring, K. and D. Snyder, personal observations off Hobe Sound, Florida).

4.21. REUSE AND CONSERVATION POTENTIAL

There is no potential for reuse associated with the proposed project activities; therefore, this is not applicable to the proposed renourishment project. Energy requirements for the proposed alternatives would be confined to fuel for the dredge, labor transportation, and other construction equipment.

4.22. URBAN QUALITY

No direct permanent impacts related to urban quality are expected as a result of the proposed project. Implementation of the proposed project would indirectly and positively impact urban quality by restoring an eroded beach, by increasing the recreational beach activity, and by increasing the tax revenue and tourism commerce.

The commercial businesses and residential properties along the project beach would benefit from the storm protection afforded by the project and incur less risk of property damage. The presence of construction equipment would temporarily detract from the aesthetics of the environment, thereby possibly temporarily affecting the localized visual aesthetics associated with urban quality in St Lucie County.

The no-action alternative would assume continued shoreline erosion, reduction of storm protection, and continued loss of recreational beach area with repercussions to tax revenues and tourism commerce.

4.23. SOLID WASTE

No impacts related to solid waste are expected as a result of this project. Precautionary measures will be included in the contract specifications for proper disposal of solid wastes. These precautionary measures include proper containment and avoidance of overflow conditions by emptying containers on a regular schedule. Disposal of any solid waste material into Atlantic waters will not be permitted.

4.24. SCIENTIFIC RESOURCES

There are no known impacts to scientific resources associated with the Applicant's preferred alternative or the No-action alternative.

4.25. NATIVE AMERICANS

None of the proposed project activities occur on land belonging to Native Americans. Implementation of the Applicant's preferred alternative would not impact Native Americans or land belonging to Native Americans.

4.26. DRINKING WATER

No municipal or private water supplies are located in or near the project site; therefore, implementing the Applicant's preferred alternative will not impact drinking water resources.

4.27. CUMULATIVE IMPACTS

Cumulative impacts are those that result from "the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR 1508.7). Cumulative impacts result from spatial (geographic) and temporal (time) crowding of environmental perturbations. The impacts may result from the accumulation of similar effects or the synergistic interaction of different effects (Council on Environmental Quality 1997).

Table 4.27-1 summarizes cumulative impacts by identifying the past, present, and reasonably foreseeable future condition of the various resources with and without the project. **Appendix J**, Cumulative Effects Assessment contains more detailed information about the cumulative impact analysis, analyzed as recommended by guidance contained in Council on Environmental Quality (1997).

4.27.1. CUMULATIVE ACTIVITIES SCENARIO

The geographic scope of this analysis includes the shoreline of St. Lucie County and Martin County between Ft. Pierce Inlet and St. Lucie Inlet (about 22 miles of shoreline) and Atlantic Ocean sand shoals between about three and six miles offshore of the central Florida coastline The project impact area extends from R-86 in St. Lucie County to R-4 in Martin County due to the proposed mixing zone (850 meters from the point of sand discharge) and potential downdrift (southerly) transport of sand in the nearshore area. Other similar projects to the north and south and all the other reasonably foreseeable actions along the shoreline of Hutchinson Island may, together with the proposed project, result in cumulative impacts. In addition to the coastline, the area includes the offshore borrow area located in a sand ridge (St. Lucie shoal) 3 miles offshore of R-88 to R-115 in water depths of approximately 36 to 43 feet. Cumulatively, the project and other similar projects may impact sand shoals 3-5 miles offshore.

4.27.1.1. Past Conditions and Activities

A Conditions Assessment Report prepared for St. Lucie County by Coastal Tech (2009: Attachment P) summarizes historical shoreline changes from R-77 through R-115. Except for the segment from R-103 to R-109, the shoreline within the study area predominantly retreated from 1972 to 2006. A volumetric study conducted by the USACE indicates that from 1997 to June 2004, the beaches of the study area cumulatively experienced slight erosion. From June 1997 to November 2004, following landfall of hurricane Frances and Jeanne (September 2004), a much stronger trend of erosion occurred.

Table 4.27-1. Summary of Cumulative Impacts

Resource	Past and Present (Baseline/Existing Condition)	Future without Project	Future with Project
Threatened and Endangered Species: Sea Turtles	Five sea turtle species occur in the area (loggerhead, green, hawksbill, Kemp's ridley, and leatherback). Loggerhead, green, and leatherback turtles nest on area beaches. Juvenile green turtles use nearshore hardbottom areas for feeding (macroalgae), resting, and shelter from predators. Past and current threats to sea turtle populations include artificial lighting, beach armoring, anthropogenic disturbance, trawling, dredging, vessel strikes, fishing gear entanglement, and ingestion of discarded anthropogenic marine debris.	Sea turtle nesting and nearshore habitat use will continue in the area. Project-specific impacts will be avoided, but ongoing threats to sea turtle populations will continue. In the absence of the project, property owners may construct seawalls or other armoring to protect their property, which may result in loss of nesting habitat and possible impacts on nearshore hardbottom habitat.	In addition to ongoing threats, the project will result in loss of a small defined area of juvenile developmental habitat (nearshore hardbottom). Sea turtles may be disturbed by turbidity and noise during construction. There is a small risk of sea turtles being struck by a construction vessel or entrained in the hopper dredge draghead; these risks will be minimized through vessel-strike avoidance and dredge-related impact mitigation measures. Due to the small spatial extent and short duration of project impacts, no significant cumulative impacts are expected.
Threatened and Endangered Species: Marine Mammals	Three endangered marine mammal species may occur in the area: Florida manatee, humpback whale, and North Atlantic right whale. Only the manatee is common. Past and current threats to marine mammal populations include vessel strikes, fishing gear entanglement, ingestion of marine debris, pollution, and underwater noise.	Marine mammals will continue to occur in the area. Project-specific impacts will be avoided, but ongoing threats to marine mammal populations will continue.	In addition to ongoing threats, marine mammals may be disturbed by turbidity and noise during construction. There is a small risk of marine mammals being struck by a construction vessel or entrainment within a hopper dredge draghead. Mortality of a manatee or North Atlantic right whale would represent a significant cumulative impact due to the small population of these species. The risk will be minimized through vessel-strike avoidance and dredge impact –related mitigation measures.
Threatened and Endangered Species: Smalltooth Sawfish	The smalltooth sawfish is an endangered species inhabiting shallow, nearshore waters. Historically, its population and range have declined, mainly due to fisheries bycatch. Other past and current threats are habitat loss and degradation, entanglement in marine debris, pollution, and anthropogenic disturbance.	Smalltooth sawfish will continue to inhabit the area. Project-specific impacts will be avoided, but ongoing threats to sawfish populations will continue and may result in further decreases in population size and range.	In addition to ongoing threats, sawfish may be disturbed by turbidity and noise during construction. There is a small risk of sawfish being entrained in the hopper dredge draghead, which will be minimized through mitigation measures. Due to the small spatial extent and short duration of project impacts, no significant cumulative impacts are expected.

Table 4.27-1. Summary of Cumulative Impacts

Resource	Past and Present (Baseline/Existing Condition)	Future without Project	Future with Project
Nearshore Hardbottom	Two nearshore hardbottom communities occur in the area. One consists of low- to medium-relief habitat with wormrock and supports hydroids, encrusting sponges, macroalgae, and turf algae. The other consists of low-relief coquina ledges with little or no epibiotic cover. These communities have historically been subjected to the dynamics of the nearshore environment including sand movement, scouring, and alternating burial/exposure.	Nearshore hardbottom areas will continue to exist in the area, subject to the natural dynamics of the nearshore environment including sand movement, scouring, and alternating burial/exposure. In the absence of the project, property owners may construct seawalls or other armoring to protect their property, which may result in impacts to nearshore hardbottom.	The project will result in burial of 1.08 acres of nearshore hardbottom habitat. However, the impact represents a small percentage of the similar habitat in the area and impacts will be mitigated through the construction of artificial reef habitat. Cumulatively significant impacts could occur if the 10-year renourishment interval is shortened due to sea-level rise.
Fish and Wildlife Resources	Nearshore soft bottom habitats including sand shoals support a variety of invertebrates and demersal fishes. Invertebrates using shoals include infaunal and epifauna species represented primarily by annelid worms, gastropods, bivalves, crustaceans, and echinoderms. Most of these species are used as food by demersal fishes.	Project-specific impacts will be avoided, but soft bottom communities would continue to be affected by natural sand movement. In the absence of the project, property owners may construct seawalls or other armoring to protect their property; which may result in impacts to nearshore soft bottom communities. Regionally, other sand shoal areas are likely to be used in support of future beach nourishment projects.	In addition to ongoing processes affecting soft bottom fish and wildlife resources, there will be localized effects of dredge and fill activities along the beach and in the offshore borrow area that may persist for a few months to a few years. Effects are not likely to be significant because resident fish and wildlife species are wide-foraging or migratory and spend only a portion of their life cycle at the borrow area and beach fill site. No significant cumulative impacts are expected.
Essential Fish Habitat	Managed species and species groups in the project area include *Sargassum*; coral, coral reefs, and live/hardbottom habitats; penaeid shrimp; spiny lobster; red drum; coastal pelagic fishes; reef fishes; dolphin and wahoo; and highly migratory pelagic species. Habitats of Particular Concern (HAPCs) for coral, coral reefs, and live/hardbottom habitats of the eastern Florida area include the *Phragmatopoma* worm reefs found in nearshore waters; nearshore hardbottom found in water depths of 0 to 4 m; and hardbottom found in water depths of 5 to 30 m.	Project-specific impacts will be avoided, but the acreage of nearshore hardbottom Essential Fish Habitat (EFH) would fluctuate with natural sand movement. Increased exposure of hardbottom may provide increased habitat for surf zone fishes, increased foraging habitat for green sea turtles, and increased refuge for juvenile fishes. In the absence of the project, property owners may construct seawalls or other armoring to protect their property, which may result in impacts to nearshore EFH.	In addition to ongoing processes affecting nearshore EFH, the project will result in the burial of 1.08 acres of nearshore hardbottom habitat which will result in an incremental loss of EFH for corals and other hardbottom groups, as well as reef fishes. However, the impact represents a small percentage of the similar habitat in the area. Unavoidable impacts will be mitigated through the construction of artificial reef habitat consisting of low to medium-relief to mimic the structure of the affected areas. Dredging will affect EFH by temporarily altering the sand shoal habitat (e.g., reducing shoal height, creating pits). However, the impact is reversible and represents a small percentage of the similar habitat in the area.

Table 4.27-1. Summary of Cumulative Impacts

Resource	Past and Present (Baseline/Existing Condition)	Future without Project	Future with Project
Water Quality	The project area consists of Class III waters which are designated as suitable for recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife. The predominant issue that affects water quality in the area is turbidity, which varies significantly under natural conditions (e.g., during storms), sometimes exceeding 29 NTU. Historically, coastal water quality has been affected by unrelated anthropogenic sources such as stormwater and effluent runoff resulting in increased nutrients and freshwater inputs. Urbanization and population growth in the region contributes to coastal water quality degradation.	Project-specific impacts would be avoided, but turbidity would continue to occur intermittently due to storm activity, rainfall, currents, and other natural phenomena. Water quality may deteriorate due to unrelated anthropogenic sources such as stormwater and effluent runoff.	In addition to the ongoing natural and anthropogenic fluctuations in water quality, local, short-term turbidity would occur adjacent to the beach fill sites and offshore borrow area. BMPs would be implemented during construction to reduce the magnitude and extent of turbidity, and adverse effects on water quality are expected to be minor. Turbidity will be monitored during construction to ensure that State water quality standards are met at the mixing zone boundary. Due to the small spatial extent and short duration of project impacts, no significant cumulative impacts are expected.

Following hurricanes Frances and Jeanne, emergency dune restoration was conducted by St. Lucie County – including placement of about 162,000 cubic yards of sand along the dune from R-98.4 to R-101.5, and from R-103.3 to the Martin County line (PBS&J, 2005) – over about 15,500 feet of dune and corresponding to a fill density of about 10 cubic yards/foot. Individual property owners have also undertaken dune restoration projects; placed quantities are unknown, but St. Lucie County believes these amounts are relatively minor.

North of the project area, the federal Ft. Pierce Shore Protection Project area (about 1.3 miles in length) has received nourishment sand since 1971. The federal project began in 1980. Since that time, 14 nourishments have placed sand on various portions of the project beach. Abutting the proposed project to the south, the federal Martin County Shore Protection Project, initiated in 1995, has renourished their four mile project three times. Most recently, Martin County nourished Bathtub Beach, about 1,000 ft of shoreline, in the Spring of 2010. SailFish Point Beach, just to the south and about 1,500 ft in length, received sand in 2005 and 2009.

4.27.1.2. Present/Ongoing Activities

There are no ongoing beach restoration activities in the project area. The St. Lucie shoal is not currently being used for any other beach restoration projects. Recreational usage along the beaches within the project area includes shore based water sports such as scuba diving, snorkeling, surfing, surf fishing, and kayaking. Additionally, the area beaches are used for sunbathing, picnicking, and exercising. Boating is a popular recreational pastime for many residents and tourists to the area. Fishing, scuba diving, and snorkeling are often done from boats in nearshore hardbottom areas close to the shore. These shallow nearshore hardbottom areas are attractive areas for scuba diving and lobster fishing as well as angling from small vessels. Angling may occur near the proposed borrow site, although there are no known fish havens near the borrow area.

4.27.1.3. Reasonably Foreseeable Future Activities

More than a decade ago, the USACE recommended a “feasibility study” for a study area extending from just south of Blind Creek (R-77) to the Martin County Line. However, due to limited funding, the USACE only partially advanced that Feasibility Study, which until recently remained substantially incomplete and without sufficient federal funding to substantially advance any USACE project. The USACE is currently completing the feasibility study but will not likely complete their project feasibility study and implementation process prior to 2012. St. Lucie County has initiated this project to address the deteriorated shoreline and emergency conditions as soon as possible with parallel development of a future federal Shore Protection Project to provide for future re-nourishment of south County beaches.

To provide for future renourishment of the project, a conceptual 50-year borrow area dredge plan has been proposed based upon the report titled “St. Lucie County Sand Search – Geotechnical Investigations – Reconnaissance Level Investigations” (Coastal Tech 2010c). The renourishment interval and volume are 10 years and 200,161 cubic yards, respectively. The proposed borrow area for Project re-nourishment are offshore

St. Lucie County in reasonable proximity to the project fill-area; the borrow can also likely yield the 50-year total estimated volume of beach compatible sand.

The proposed Martin County Beach Erosion Control Project (USACE 2008) would authorize construction of a protective and recreational beach along 4 miles of shorefront southward from the St. Lucie County line to near the limit of Stuart Public Beach Park (R-1 to R-25). The authorized project was initially constructed in 1996 with a planned periodic renourishment interval of 11 years. Federal participation (cost-sharing) is authorized for 50 years from date of initial construction and expires in 2046. The previously approved borrow area, used for initial construction, has been depleted. Therefore, Martin County has investigated three sand shoals including portions of the St. Lucie Shoal complex located approximately 3 to 7 miles offshore Martin and St. Lucie Counties. Martin County has proposed a potential borrow area south of the St. Lucie Shoal as a source of beach-compatible sand. The total sand needed for the remainder of the 50-year life of the project is estimated to be between 2.4 and 4.0 million cubic yards. The next renourishment phase is scheduled for 2011 and will involve the placement of approximately 589,600 cubic yards of material along the 4-mile project area.

Regionally, beach nourishment is expected to continue in the coming years, compounding opportunities for recurring impacts. In southeast Florida alone, approximately 100 dredging events are projected to occur between 1969 and 2050 using at least 100,000,000 cubic yards of sediment in an area that is 4 miles wide by 120 miles long (from Dade County to Martin County) (USACE 1996).

4.27.1.4. Sea-Level Change

USACE Circular No. 1165-2-211 provides guidance for incorporating the direct and indirect physical effects of projected future sea-level change in managing, planning, engineering, designing, constructing, operating, and maintaining USACE projects. Potential relative sea-level change must be considered in every USACE coastal activity as far inland as the extent of estimated tidal influence.

IPCC (2007) estimated that global mean sea level (GMSL) rose at an average rate of about 1.7 ± 0.5 mm/year during the twentieth century. NOAA (http://www.co-ops.nos.noaa.gov) publishes mean sea level (MSL) trends for the Atlantic coast of Florida. Using data (1928 – 1999) from Station 8720220 Mayport and data (1931 – 1981) from Station 8723170 Miami Beach, MSL rises 0.238 meters and 0.244 meters (0.80 and 0.78 feet) per century. These rates correspond to 2.38 and 2.44 millimeters per year. Adjusting the rate for the project location with respect to the two tide gauges provide a project area low (baseline) total local sea level rise of 155 millimeters over a 50-year period.

Based on the average of these two stations, the historical rate of change in MSL in the project area is estimated to be .0024 m/year (**Table 4.27-2**). In accordance with USACE Circular No. 1165-2-211, the historical rate of change can be used to estimate the “low” rate of future change. The “intermediate” and “high” rates of local MSL change were calculated using Equations 2 and 3 in Appendix B of USACE Circular No. 1165-2-211.

Table 4.27-2. Estimated Sea Level Rise in South St. Lucie County, FL

Rate	Average Sea Level Rise m/yr (ft/yr)	Total Local Sea Level Rise m/yr (ft/yr)	50-yr Total Local Sea Level Rise m (ft)
Low	0.0024 (0.0078)	0.0009 (0.0031)	0.0472 (0.1550)
Intermediate	0.0041 (0.0132)	0.0014 (0.0048)	0.0725 (0.2378)
High	0.0118 (0.0382)	0.0038 (0.0123)	0.1897 (0.6225)

The worst-case scenario for sea level rise adds a little more than ½ foot to average sea elevations over the next 50 years.

The U.S. Climate Change Science Program (CCSP 2009) Synthesis and Assessment Product 4.1 (SAP 4.1) *Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region* details both how sea-level change affects coastal environments and what planners should address to protect the environment and sustain economic growth. SAP 4.1 represents the most current knowledge on implications of rising sea levels and possible adaptive responses. Many options are available for protecting land from inundation, erosion, and flooding ("shore protection"), or for minimizing hazards and environmental impacts by removing development from the most vulnerable areas ("retreat"). However, policymakers have not decided whether the practice of protecting development should continue as sea level rises, or be modified to avoid adverse environmental consequences and increased costs of shore protection. Most shore protection structures are designed for the current sea level, and retreat policies that rely on setting development back from the coast are designed for the current rate of sea-level rise. Those structures and policies would not necessarily accommodate a significant acceleration in the rate of sea-level rise.

Future sea-level change is likely to result in both direct and indirect impacts on nearshore marine resources in the project area. Direct impacts could include changes in the areal extent of exposed hardbottom habitat due to sand movement. Indirect impacts could result from increased beach erosion which may prompt more frequent (and possibly more extensive) beach nourishment projects in the area. The largest uncertainty is predicting the level and types of human activities that may be conducted to protect the shoreline in response to advancing sea level.

4.27.2. CUMULATIVE IMPACTS BY RESOURCE

In accordance with the approach recommended by the Council on Environmental Quality (1997), this analysis focuses on the potential impacts that are most important or meaningful. The marine resources of most interest for the cumulative analysis are threatened and endangered species, hardbottom, fish and wildlife resources, EFH, and water quality.

4.27.2.1. Threatened and Endangered Species

4.27.2.1(a). Sea Turtles

As discussed in **Section 3.3.1**, five endangered or threatened sea turtle species occur in the area (loggerhead, green, hawksbill, Kemp's ridley, and leatherback). Loggerhead, green, and leatherback turtles nest on area beaches. Juvenile green turtles use nearshore hardbottom ledges for feeding (macroalgae), resting, and shelter from predators.

Species recovery plans indicate that past and current threats to sea turtle populations include artificial lighting, beach armoring, anthropogenic disturbance, trawling, dredging, vessel strikes, fishing gear entanglement, and ingestion of marine debris (NMFS and USFWS 1991a; 1992a,b; 1993; 2008). These impacts are widespread, diffuse, and ongoing, and will continue in the future regardless of whether this project occurs.

The project will result in burial of a small area of nearshore hardbottom, which would represent an incremental loss of developmental habitat for juvenile sea turtles. The animals will be prevented from using the buried hardbottom habitat as long as macroalgae and seafloor structures are covered. However, the area to be buried (1.08 acres) is a small percentage of the total habitat area available in the region, representing approximately 10% of the total approximate 10.4 acres of total hardbottom in and adjacent to the project area. Therefore, the impact to sea turtle developmental habitat is considered minor. Cumulatively, other beach nourishment projects in the area have provided successful mitigations for permanent impacts.

In addition to the habitat loss, sea turtles may be disturbed by turbidity and noise during construction, and there is a small risk of a sea turtle being struck by a construction vessel or entrained in the hopper dredge draghead. To reduce the risk of impacts from dredging and vessel strikes, the project will comply with the "Sea Turtle and Smalltooth Sawfish Construction Conditions" (NOAA Fisheries, 2006) and "Vessel Strike Avoidance Measures and Reporting for Mariners" issued by NOAA Fisheries, Southeast Region. The Applicant proposes the use of trained and NMFS-approved protected species observers on board the dredge vessel during all dredging operations. Dredge support vessel operators and crews will be instructed to maintain a constant lookout for sea turtles during transits and maneuvers. With mitigation measures in place, the potential for sea turtle "takes" due to dredging and vessel strikes is expected to be significantly reduced.

Although there is a risk of a small number of sea turtle "takes" due to dredging and vessel strikes, the impacts would not likely be detectable cumulatively, based on the other known sources of impact to sea turtles. The National Academy of Sciences (1990) estimated that between 5,000 and 50,000 loggerheads were killed annually by the shrimping fleet in the southeast U.S. Atlantic and Gulf of Mexico. Mortality associated with shrimp trawls was estimated to be 10 times greater than that of all other human-related factors combined. Most of these turtles were neritic juveniles, the life stages most critical to the stability and recovery of sea turtle populations (NMFS and USFWS 2008).

The FPL nuclear power plant just north of the project area regularly entrains marine turtles in their cooling water intake system, and FPL holds an incidental take permit for this impact. The plant has an ongoing program that captures almost all turtles before they enter the plant, where they would die. Some turtles are killed each year and hatchlings and juveniles may pass through the net and die without the notice of the plant personnel. Mortality at the plant represents the most significant ongoing impact to marine turtles along the Hutchinson Island shoreline.

Increased shoreline development as a result of the project could result in additional indirect impacts on sea turtle nesting due to increased artificial lighting, increased beach traffic, etc. However, the project area upland offers little opportunity for future development growth. More importantly, the potential for indirect development affects has been minimized in the design of the Applicant's preferred plan. In consultation with the FDEP, St. Lucie County has delineated the project area to (a) include that portion of the study area that is designated by FDEP as "critically eroded" – thus qualified for State cost-sharing and where beach nourishment appears feasible for obtainment of a FDEP permit, but (b) exclude shoreline segments where minimal or no beach-front development exists and where beach nourishment would contribute little to storm damage prevention benefits.

Due to the small spatial extent and short duration of activities, no significant impacts on sea turtles are expected during a single nourishment event. Over the next 50 years, assuming a 10-year nourishment interval, the potential for significant cumulative impacts from repeated activities in the same area is low. However, if the interval is reduced due to future sea-level change, the potential for significant cumulative impacts will increase. Also, depending on the timing of beach nourishment project(s) in northern Martin County, there is the possibility of concurrent, project-related impacts on local sea turtles. If future projects in southern St. Lucie and northern Martin County are conducted concurrently, cumulative minor local habitat loss due to burial of hardbottom areas in multiple areas may elevate the level of the impacts. Also, the range of influence from noise, vessel traffic, and turbidity could overlap. However, the Projects to the north and south have both provided mitigation for their permanent impacts and, have avoided additional impacts in previous renourishments. Future performance of these projects will likely continue to avoid additional impacts.

4.27.2.1(b). Marine Mammals

As discussed in **Section 3.3.2**, three endangered marine mammal species may occur in the area: the Florida manatee, humpback whale, and North Atlantic right whale. Of these, only the manatee is common regionally. The two endangered whales are rare and may be present seasonally (December to March). Manatees are usually found in quiescent inshore waters and would likely be only very occasional visitors along the beach; they would likely only very rarely occur in the borrow area three miles offshore.

Historically, the most significant threat presently faced by Florida manatees is death or serious injury from boat strikes (USFWS 2001). Other known causes of manatee deaths include entrapment or crushing in water control structures and navigational locks, poaching and vandalism, entanglement in shrimp nets, monofilament line (and other fishing gear), entrapment in culverts and pipes, and ingestion of debris. Natural causes of death include disease, parasitism, reproductive complications, and other non-human-related injuries, as well as occasional exposure to cold and red tide. Vessel strikes will continue to be a significant threat to the Florida manatee population regardless of whether this project is conducted.

For humpback whales and right whales, ship collisions and fishing gear entanglements are the most common anthropogenic causes of mortality (NMFS 1991, 2005). Other potential threats are habitat degradation, noise, contaminants, underwater explosive activities, climate and ecosystem change, and commercial exploitation. These impacts are widespread, diffuse, and ongoing, and will continue in the future regardless of whether this project occurs.

Vessel strikes comprise the most important potential impact on marine mammals. Because the existing manatee and Northern right whale populations are so small any vessel striking a manatee or North Atlantic right whale during the project would represent a significant cumulative impact. To reduce the risk of vessel strikes, the project will comply with the "Vessel Strike Avoidance Measures and Reporting for Mariners" issued by NOAA Fisheries, Southeast Region. Trained and NMFS-approved protected species observers will be used on board the dredge vessel during all dredging operations, and dredge support vessel operators and crews will be instructed to maintain a constant lookout for marine mammals during transits and maneuvers. With these mitigation measures in place, the potential for marine mammal "takes" due to vessel strikes is expected to be significantly reduced.

Due to the small spatial extent and short duration of activities, a single nourishment event will not likely produce significant impacts on endangered or threatened marine mammals. However, the project may result in temporary disturbance of marine mammals due to turbidity and noise during construction. These are minor impacts that are not likely to be significant cumulatively in context with existing stresses on marine mammal populations. The proposed 10-year nourishment interval over the next 50 years will help keep the potential for significant cumulative impacts from repeated individual nourishment projects low. However, if future sea-level rise results in a shorter interval between nourishments, the potential for significant cumulative impacts will increase. The timing of beach nourishment project(s) in northern Martin County, may increase concurrent, project-related impacts on local marine mammals. If future projects in southern St. Lucie and northern Martin County are conducted concurrently, the range of influence from turbidity, noise, and vessel traffic will extend spatially, if not temporally.

4.27.2.1(c). Smalltooth Sawfish

As discussed in **Section 3.3.3**, the smalltooth sawfish is an endangered demersal fish species inhabiting shallow, nearshore waters. Historically, its population has declined and its range has contracted, mainly due to fisheries bycatch (NMFS 2009). Other past and current threats are habitat loss and degradation, entanglement in marine debris, pollution, and anthropogenic disturbance (NMFS 2009). These widespread ongoing impacts are expected to continue in the future regardless of whether this project is conducted.

Construction-related turbidity and noise may disturb the smalltooth sawfish. There is also a small risk of sawfish being entrained in the hopper dredge draghead. To reduce the risk of impacts, the project will comply with the "Sea Turtle and Smalltooth Sawfish Construction Conditions" (NOAA Fisheries 2006). With these mitigation measures in place, the potential for "takes" of smalltooth sawfish during dredging is expected to be significantly reduced.

The small spatial extent and short duration of construction activities suggest that any single nourishment event is not very likely to impact smalltooth sawfish. Project construction may result in temporary disturbance or dislocation of these animals from dredging, turbidity and noise. These are minor impacts not likely to produce significant cumulative impacts in context with existing stresses on the population. Over the next 50 years, assuming a 10-year renourishment interval, the potential for significant cumulative impacts from repeated individual nourishment projects in the same area is low. However, if the interval is reduced due to future sea-level change, the potential for significant cumulative impacts will increase. The timing of beach nourishment project(s) in northern Martin County may result in concurrent, overlapping impacts on smalltooth sawfish from the construction of two projects at the same time. If future projects in southern St. Lucie and northern Martin County are conducted concurrently, the range of influence from noise, vessel traffic, and turbidity could overlap. Also, if the projects use the same sand shoal(s), dredging-related impacts could overlap.

4.27.2.2. Hardbottom

As discussed in **Section 3.4**, two types of nearshore hardbottom communities occur in the area. Hardbottom Community One consists of low- to medium-relief habitat with a significant wormrock component and supports fauna such as hydroids, encrusting sponges, macroalgae, and turf algae. Hardbottom Community Two includes low-relief consolidated coquina rock ledges with little or no epibiotic cover. These hardbottom communities have are constantly subjected to the dynamics of the nearshore environment including sand movement, scouring, and alternating burial/exposure. These natural impacts will continue regardless of whether the project occurs.

Available natural resources information document no past or ongoing anthropogenic impacts to nearshore hardbottom communities in the project area. If the project is not implemented, property owners may construct seawalls or other armoring to protect their property, which may result in impacts to nearshore hardbottom due to additional sand movement and scour.

The main unavoidable adverse impact from the applicant's preferred plan is the burial of an estimated 1.08 acres of nearshore hardbottom habitat. The area buried (1.08 acres) represents approximately 10% of the total approximate 10.4 acres of total hardbottom in the nearshore of the project beach. Additional, extensive nearshore habitat occurs north of the project area. The overall impact to nearshore hardbottom communities is considered minor. The Applicant proposed mitigation for unavoidable impacts through construction and monitoring of artificial reef habitat. The artificial reef consists of low to medium-relief intended to mimic the structure of the affected areas. The cumulative impact to nearshore hardbottom communities is not expected to be significant.

Over the next 50 years, assuming a 10-year renourishment interval, the potential for significant cumulative impacts from repeated individual nourishment projects in the same area is low. However, if the interval is reduced due to future sea-level rise, the potential for significant cumulative impacts on nearshore hardbottom will increase. More frequently conducted nourishment projects will allow less recovery time for hardbottom communities temporarily buried by each project. Under any of the estimated sea-level changes (low, intermediate, or high), the nearshore hardbottom habitat likely will continue to exist. However, the areal extent and location of exposed hardbottom may change. For example, if the shoreline retreats, additional outcrops may become exposed in shallow water. Hardbottom areas farther offshore would be in slightly deeper water and could be less likely to be affected by beach fill projects. Over the next 50 years, sea-level change and beach nourishment projects are likely to be significant influences on the distribution and characteristics of nearshore hardbottom communities in the area.

A federal shoreline restoration project in northern Martin County begins at the southern terminus of the proposed project area (the St. Lucie County – Martin County Line). A permit application for renourishment on this project (first nourished in 1995) is now under regulatory review. The simultaneous construction of the projects could have result in positive and negative impacts. The nourishment of 8 miles of beach would slow the overall erosion rate of either project constructed alone, but could impact a greater area of hardbottom habitat, both north and south of the combined project area as the projects erode by the dispersion of a greater volume of sand.

4.27.2.3. Fish and Wildlife Resources

As discussed in **Sections 3.5** and **3.7**, nearshore soft bottom habitats including sand shoals support a variety of invertebrates and demersal fishes. Invertebrates using shoals include infaunal and epifauna species represented primarily by annelid worms, gastropods, bivalves, crustaceans, and echinoderms. Demersal fishes prey on most of these taxa.

The project will result in localized effects of dredge and fill activities along the beach and in the offshore borrow area that may persist for a few months to a few years. Significant effects are unlikely because resident fish and wildlife species are wide-foraging or migratory and spend only a portion of their life cycle at the borrow area and beach fill site. No significant cumulative impacts are expected.

Over the next 50 years, assuming a 10-year renourishment interval, the potential for significant cumulative impacts on fish and wildlife resources from repeated individual nourishment projects in the same area is low. However, if the interval is reduced due to future sea-level rise, the potential for significant cumulative impacts will increase. In addition, beach restoration projects in Martin County may occur close to the same timeframe as the St. Lucie County project, use similar or nearby shoals for beach sand and thus create the potential for concurrent and overlapping impacts on benthic communities in the borrow area. The potential for significant cumulative impacts can be reduced by leaving portions of the existing shoals undisturbed. These “refuge patches” will help reduce the potential for significant cumulative impacts by providing a nearby source of plant and animal re-colonization propagules for the disturbed borrow area. Further, joint project planning by the counties can include overall impact minimization when selecting times and locations for dredging and nourishments

4.27.2.4. Essential Fish Habitat

As discussed in **Section 3.6**, managed species and species groups with EFH in the project area include *Sargassum*; coral, coral reefs, and live/hardbottom habitats; penaeid shrimp; spiny lobster; red drum; coastal pelagic fishes; reef fishes; dolphin and wahoo; and highly migratory pelagic species. HAPCs for coral, coral reefs, and live/hardbottom habitats of the eastern Florida area include the *Phragmatopoma* worm reefs found in nearshore waters; nearshore hardbottom found in water depths of 0 to 4 m; and hardbottom found in water depths of 5 to 30 m.

The project will result in the burial of 1.08 acres of nearshore hardbottom habitat which will result in an incremental loss of EFH for hardbottom and coral species as well as reef fishes. However, the area to be buried (1.08 acres) is a small percentage of the total habitat area available in the region, representing approximately 10% of the total approximate 10.4 acres of total hardbottom in and adjacent to the project area. Dredging will affect EFH by temporarily altering the sand shoal habitat (e.g. temporarily reducing shoal height and creating pits). However, the impact is reversible and represents a small percentage of the similar habitat in the area. Due to the small spatial extent and short duration of project impacts, no significant cumulative impacts on EFH are expected. Assuming a 10-year renourishment interval, the potential for significant cumulative impacts from repeated individual nourishment projects in the same area is low. However, as noted above under Hardbottom, if the renourishment interval decreases due to sea-level rise, the potential for significant cumulative impacts on EFH will increase. Over the next 50 years, sea-level change and beach nourishment projects will likely exert significant influences on the distribution and characteristics of nearshore EFH.

4.27.2.5. Water Quality

As discussed in **Section 3.9**, the project area consists of Class III marine waters, designated as suitable for recreation and propagation and maintenance of a healthy, well-balanced population of fish and wildlife. Turbidity varies significantly under natural conditions (e.g., during storms), sometimes exceeding 29 NTU and presents the most dynamic component of water quality along the shoreline. Historically, anthropogenic sources such as stormwater and effluent runoff have affected coastal water quality, resulting in increased nutrients and freshwater inputs. Urbanization and population growth in the region contributes to coastal water quality degradation. These types of impacts are expected to continue in the future regardless of whether the project is implemented.

The project will cause temporary, localized water column turbidity in the offshore borrow area and along the project shoreline. Construction BMPs should reduce the magnitude and extent of turbidity, resulting in only minor adverse effects on water quality. Turbidity monitoring during construction will ensure that the project maintains state water quality standards at the mixing zone boundary.

Due to the small spatial extent and short duration of the dredge and fill activities and the BMPs to be implemented during construction, water quality impacts are not expected to be significant. Assuming a 10-year renourishment interval, the potential for significant cumulative impacts from repeated individual nourishment projects is low. If sea-level rise results in more frequent nourishment, the potential for significant cumulative impacts on water quality will increase. Also, depending on the timing of beach nourishment project(s) in northern Martin County, there is the possibility of concurrent, overlapping water quality impacts.

4.27.3. CONCLUSIONS

Ongoing beach restoration activities in the area include USACE shore protection projects at Ft. Pierce and the Martin County Shore Protection Project immediately south of the proposed project area. Long-term monitoring of those projects has not revealed cumulative impacts, and USACE and FDEP have found the mitigations for initial project impacts successful in each case. The St. Lucie shoal is not currently in use for any other beach restoration project. However, in addition to the proposed project with a 10-year renourishment interval, reasonably foreseeable future activities include Federal beach restoration projects in St. Lucie County and Martin County. Regionally, dredging projects for beach nourishment are expected to continue, compounding opportunities for recurring impacts. Ongoing recreational usage of the nearshore environment includes fishing, boating, diving, snorkeling, and beach recreation activities.

Future sea-level change may result in significant direct and indirect impacts to nearshore marine resources in the project area. Direct impacts could include changes in the areal extent of exposed hardbottom habitat due to sand movement. Indirect impacts could result from increased beach erosion which may prompt more frequent (and possibly more extensive) beach nourishment projects in the area. Predicting sea level rise and the level and types of human activities that may be conducted to protect the shoreline in response to advancing sea level comprise the largest uncertainties in estimating cumulative impacts.

Over the next 50 years without the project, important factors affecting the nearshore environment are likely to include sea-level change and ongoing, low-impact human uses such as fishing, diving and snorkeling, and boating. If the project is not implemented, property owners may construct seawalls or other armoring to protect their property, which may result in impacts to nearshore hardbottom due to additional sand movement and scour.

If the Applicant's preferred project occurs, burial of an estimated 1.08 acres of nearshore hardbottom habitat will represent the most important direct impact. This area serves as developmental habitat for sea turtles and EFH for coral/hardbottom biota and reef fishes. However, the area to be buried (1.08 acres) represents approximately 10% of the total approximate 10.4 acres of total hardbottom in and adjacent to the project area and a very small fraction of hardbottom resources along the Hutchinson Island shoreline. In addition, construction of artificial reef habitat in the same nearshore area will mitigate the impacts. While the proposed mitigation would occur closer to shore than the Ft. Pierce and Martin County projects, results of other mitigations suggest that if the mitigation is located appropriately (does not become permanently buried), it should develop similar habitat to that impacted by the project. Two alternatives (the Beach and Dune Restoration with T-Head Groins and Beach Fill to Restore the 1972 Dune with a 70-ft Berm) would impact a greater area of hardbottom habitats (1.13 and 1.34 acres). Other alternatives provide significant reductions in direct impact to hardbottom habitat.

Endangered or threatened marine species that may occur in the project area include five species of sea turtles, the Florida manatee, the North Atlantic right whale, the humpback whale, and the smalltooth sawfish. Any vessel striking a manatee or North Atlantic right whale during the project would represent a significant cumulative impact because the existing populations are so small. Vessel strikes (or dredging impacts) on the other species, while obviously of concern, are not likely to represent a significant cumulative impact on the population. To reduce the risk of vessel strikes, the project will comply with the "Vessel Strike Avoidance Measures and Reporting for Mariners" issued by NOAA Fisheries, Southeast Region. Conscientious application of all appropriate mitigation measures should minimize the potential for impacts to endangered and threatened species.

For nearshore resources, the project creates a relatively low potential for significant cumulative impacts from repeated individual renourishment events. However, if future sea-level rise results in more frequent nourishment, the potential for significant cumulative impacts will increase. For example, more renourishment projects will provide less recovery time for hardbottom communities temporarily buried with each project. In addition, depending on the timing of future Federal beach nourishment project(s) in St. Lucie County and Martin County, there is the possibility of concurrent, overlapping impacts from those two projects. Avoidance of significant impacts to offshore shoals or their depletion is a potential impact that will require ongoing and long-term coordination and management between the local, state, and federal government agencies interested in long-term use of that resource.

4.28. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

4.28.1. IRREVERSIBLE

An irreversible commitment of resources is one in which the ability to use a resource is lost forever. The use of sand from offshore or upland borrow areas would irreversibly commit those sand resources to this project and preclude their use for future nourishment projects. However, the offshore borrow area for this project is estimated to contain 1.3 million cubic yards of beach-compatible sand, which is more than twice the sand required for the project (about 610,000 cubic yards). To provide for future re-nourishment of the project area, St. Lucie County has developed a conceptual 50-year borrow area dredge plan that identifies nearby and adjacent borrow areas with sufficient beach compatible sand to meet the 50-year project life.

Use of sand from offshore borrow areas would also irreversibly preclude its current use as habitat for benthic organisms. However, portions of the existing shoals are proposed to be left undisturbed as “refuge patches” to minimize impacts to existing benthic resources and to provide for re-colonization of disturbed borrow areas. Sufficient remaining sand reserves within and adjacent to the borrow area will provide for re-colonization of benthic organisms. Due to the dynamic nature of nearshore benthic environments, sand used to nourish the beach will eventually disperse in the nearshore areas and create habitat for shallow water benthic communities.

Impacts of beach restoration on nearshore hardbottom communities are reversible. These nearshore hardbottom areas are cyclically covered and exposed due to seasonal and other temporal changes in beach profiles. In view of the natural, highly dynamic fluctuations in exposure and burial of the nearshore rock resource and the modest scale of the proposed beach fill activity, abandonment of the project at any point can be reasonably anticipated to result in the near or wholly complete recovery of existing conditions.

4.28.2. IRRETRIEVABLE

An irretrievable commitment of resources means that opportunities for other uses are foregone for the period of the Proposed Action. Typically, it refers to the use of renewable resources, including human effort, and to other utilization opportunities foregone in favor of the Proposed Action.

The Proposed Action will result in the temporary commitment of nearshore hardbottom areas as locations for placement of beach sand, which is a temporary loss of habitat use during the period of the Project. The loss will be mitigated through the implementation of a program of nearshore artificial reef construction (see **Appendix D: Draft Mitigation Plan**). As noted previously, impacts of beach restoration on nearshore hardbottom communities are reversible and do not represent an irretrievable commitment of these resources for Project use.

4.29. UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

The main unavoidable adverse impact from the proposed project is the burial of an estimated 1.08 acres of nearshore hardbottom habitat. Burial of nearshore hardbottom would result in a local reduction of macroalgae and invertebrates that could modify the nearshore food web. Loss of macroalgae would be more severe in summer due to the presence of annual species. Re-exposure of hardbottom is possible due to high-energy dynamics of the area and equilibration of beach fill. Re-colonization of re-exposed hard substrates by worm rock and turf and macroalgae is probable as these organisms have high recruitment capability. Potential impacts by burial are considered to be minor as the 1.08 acres that will be permanently buried represents approximately 10% of the total approximate 10.4 acres of total hardbottom in and adjacent to the project area.

In addition to the direct impacts on epibiota, burial of nearshore hardbottom areas will result in an incremental loss of EFH for reef-associated fishes as well as developmental habitat for juvenile sea turtles. These animals will be prevented from using the buried hardbottom habitat as long as macroalgae and seafloor structures are covered. However, the area to be buried is a small percentage of the total habitat area available for use and therefore the impact is considered minor.

Due to the configuration of nearshore hardbottom habitat in the area, some level of impact to these areas is unavoidable for a beach nourishment project. The project has been designed to avoid and minimize the impact to the rock habitat to the extent practicable, while maintaining the requisite level of shore protection. Construction of artificial reef habitat will mitigate for unavoidable impacts.

To offset lost ecological functions from the burial of nearshore hardbottom, the County proposes to construct artificial reef(s) in comparable locations. UMAM calculations (**Appendix D**) indicate a requirement for 0.98 acres of artificial reef creation. St. Lucie County proposes to construct the mitigation reef prior to constructing the beach

Other unavoidable adverse impacts to the marine environment include:

- Burial of infauna and non-motile epifauna in nearshore sand bottom areas due to placement of beach fill. Recovery will depend on the ability of buried organisms to burrow through the sediment layer and the ability of adjacent populations to recolonize the area. However, the affected area is a small percentage of the total sand bottom habitat in the region and therefore the impact is considered minor.
- Impacts to infaunal communities in the offshore borrow area due to sand removal and habitat alteration. These impacts are reversible, as the affected areas will gradually fill with sand from adjacent areas and be recolonized by infauna. Portions of the existing shoals are proposed to be left undisturbed as “refuge patches” to minimize impacts to existing benthic resources and also provide for re-colonization of benthic resources in the disturbed borrow areas.
- Temporary, localized water column turbidity in the offshore borrow area and along the project shoreline. BMPs implemented during construction should

reduce the magnitude and extent of turbidity and the project should result in only minor, temporary adverse effects on water quality. Turbidity will be monitored during construction to ensure that turbidity from construction activities conforms with State water quality standards at the mixing zone boundary.

- Temporary, localized air quality and noise impacts due to emissions from offshore and onshore construction equipment
- Temporary aesthetic/visual impacts due to the presence of construction equipment in the offshore borrow area and along the project shoreline
- Temporary loss of recreational use of the beach and adjacent nearshore areas during construction. The impact to recreational opportunities will be minor because the project area is a small percentage of the total area available for similar recreational activities in St. Lucie County

4.30. LOCAL SHORT-TERM USES AND MAINTENACE/ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The project is expected to produce localized, short-term impacts on nearshore benthic communities and water quality but is not likely to cause significant adverse impacts on long-term productivity. Shoreline protection using periodic beach nourishment is an ongoing activity along much of the Florida shoreline. Beach nourishment projects have a temporary and short-term impact on nearshore biological resources and local offshore biological communities when offshore dredging supplies the nourishment sand. Most motile organisms (fishes, crabs, and some sand dwelling organisms) within the offshore borrow area and nearshore fill zone should be able to escape these areas during construction. Less-motile individuals that are unable to escape from construction will be lost, but lost populations of those individuals typically recolonize rapidly after project completion. The Project will produce temporary turbidity that is not expected to result in significant long-term water quality degradation. Short-term reductions in primary productivity and reproductive and feeding success of invertebrate species and fish are expected. These impacts should not negatively affect the sustainability of these populations given the localized scale of impacts and the proposed creation of artificial reef or reefs that will mimic the existing habitat (see **Appendix D: Draft Mitigation Plan**). The proposed project is not expected to have any significant, long-lasting impacts on sandy beach infaunal communities.

4.31. INDIRECT EFFECTS

Some prior studies have concluded that beach nourishment projects lead to greater development, tourism, investment, and subsequently greater long-term requirements for shoreline protection (National Resource Council Committee on Beach Nourishment and Protection 1995, Pilkey and Dixon 1996, Dean 1999). However, other studies concluded that shoreline development is fostered mainly by economic factors other than public investment in shoreline protection (Cordes and Yezer 1998, Cordes et al. 2001). If increased shoreline development were to occur, this could result in additional indirect ecological impacts such as adverse effects on sea turtle nesting due to increased artificial lighting, etc.

Few sites in the uplands adjacent to the project area remain open for development, so there is little or no opportunity for future development growth adjacent to the project beach. The existing shoreline includes a mix of residential, commercial (lodging), and public park facilities. More importantly, the potential for indirect development affects has been minimized in the design of the Proposed Action. In consultation with the FDEP, St. Lucie County has delineated the project area to (a) include that portion of the study area that is designated by FDEP as "critically eroded" – thus qualified for State cost-sharing and where beach nourishment appears feasible for obtainment of a FDEP permit, but (b) exclude shoreline segments where minimal or no beach-front development exists and where little or no storm damage prevention benefits would be realized via beach nourishment.

Selection of the No Action alternative could lead indirectly to losses to property due to storm erosion. This may lead to a tempering or reduction of future development, and/or abandonment or dereliction of existing development (i.e., decreased or lessened investment). Alternatively, it could generate increased demand for shoreline armoring by private interests as developed properties become imperiled by storm erosion.

4.32. COMPATIBILITY WITH FEDERAL, STATE, AND LOCAL OBJECTIVES

Recognizing the importance of the state's beaches, the Florida Legislature in 1986 adopted a posture of protecting and restoring the state's beaches through a comprehensive beach management planning program. Under the program, the FDEP's Bureau of Beaches and Coastal Systems evaluates beach erosion problems throughout the state seeking viable solutions. The primary vehicle for implementing the beach management planning recommendations is the Florida Beach Erosion Control Program, which is a program established for the purpose of working in concert with local, State, and Federal governmental entities to achieve the protection, preservation and restoration of the coastal sandy beach resources of the state. Eligible activities include beach restoration and nourishment activities, project design and engineering studies, environmental studies and monitoring, inlet management planning, inlet sand transfer, dune restoration and protection activities, and other beach erosion prevention related activities consistent with the adopted Strategic Beach Management Plan.

The FDEP has classified most of the south St. Lucie County beaches as "critically eroded areas", which is a level of erosion that threatens substantial development, recreational, cultural, or environmental interests. One way to restore eroded beaches is through beach nourishment where sand is collected from an offshore location by a dredge and is piped onto the beach. A slurry of sand and water exits the pipe on the beach and once the water drains away, only sand is left behind. Bulldozers move this new sand on the beach until the beach matches the design profile. Beach nourishment is a preferred way to add sand to a system because it provides a significant level of storm protection benefits for upland properties and includes the fewest impacts to the coastal system. An additional benefit of beach restoration projects is that they quickly restore shorebird and marine turtle habitat.

St. Lucie County's coastline is a valuable resource providing storm protection, recreation, economic value, and wildlife habitat. The preservation of this coastline is a long-term, ongoing County commitment. The County's main objective is to abate ongoing and historical beach erosion; specific County criteria for plan formulation include optimizing project performance and cost effectiveness – generally consistent with USACE planning regulations for shore protection projects, and minimizing environmental impacts to the extent feasible.

Along many coastal areas, including the project area, erosion threatens oceanfront properties. Beach and dune restoration is necessary to help prevent the loss of property and/or the construction of numerous emergency shoreline armoring structures and other stopgap measures that would very likely continue to narrow the beach. With beach narrowing, sea turtle nesting habitat diminishes until (ultimately) no nesting habitat remains. While narrow beaches may still support nesting, if high tides reach a seawall or the dune line on a regular basis hatching success dramatically decreases from nest inundation and washout. In addition, recreational use of narrowed beaches diminishes. Therefore, the proposed project is consistent with Federal, State, and local objectives.

4.33. CONFLICTS AND CONTROVERSY

Conflicts and controversy will be identified and addressed throughout the coordination with agencies, and through the public comments.

4.34. UNCERTAIN, UNIQUE, OR UNKNOWN RISKS

The proposed activity is commonly conducted, and has previously been permitted and conducted in St. Lucie County. No uncertain, unique, or unknown risks have been identified to date.

4.35. PRECEDENT AND PRINCIPLE FOR FUTURE ACTIONS

An emergency beach fill project in 2004-2005 is the only precedent beach nourishment action taken in the project area. This EIS considers a single beach fill project with potential for a renourishment interval of 10 years. The project permit, if issued would allow only a single nourishment event.

4.36. ENVIRONMENTAL COMMITMENTS

St. Lucie County is committed to avoiding, minimizing, or mitigating for adverse effects by implementing protection measures and complying with all environmental permit requirements. In addition to the mitigation and monitoring proposed in **Section 2.6**, St. Lucie County is committed to the following protection measures during project construction.

4.36.1. SEA TURTLES

St. Lucie County will comply with the following NMFS construction conditions to protect swimming sea turtles.

- The permitee shall instruct all personnel associated with the project of the potential presence of the species and need to avoid collisions with sea turtles. All construction personnel are responsible for observing water-related activities for the presence of sea turtles.

- The contractor shall advise all personnel that there are civil and criminal penalties for harming, harassing, or killing sea turtles, which are protected under the Endangered Species Act of 1973.

- Siltation barriers shall be made of material in which a sea turtle cannot become entangled, be properly secured, and be regularly monitored to avoid entrapment. Barriers may not block sea turtle entry or exit from designated critical habitat without prior agreement from the National Marine Fisheries Service's Protected Resources Division, St. Petersburg, Florida.

- All vessels associated with the construction project shall operate at "no wake/idle" speeds as all times while in the construction area and while in water depths where the draft of the vessels provides less than a four-foot clearance from the bottom. All vessels will preferentially follow deep-water routes (e.g., marked channels) whenever possible.

- If a sea turtle is seen within 100 yards of the active daily construction/dredging operation or vessel movement, all appropriate precautions shall be implemented to ensure its protection. These precautions shall include cessation of operation of any moving equipment closer than 50 feet of a sea turtle. Operation of any mechanical construction equipment shall cease immediately if a sea turtle is seen within a 50-foot radius of the equipment. Activities may not resume until the protected species has departed the project area on its own volition.

- Any collision with and/or injury to a sea turtle shall be reported immediately to the National Marine Fisheries Service Protected Resources Division (727-824-5312) and the local authorized sea turtle stranding/rescue organization.

4.36.2. MANATEES

St. Lucie will comply with the following conditions intended to protect manatees from direct project effects:

- All personnel associated with the project shall be instructed about the presence of manatees and manatee speed zones, and the need to avoid collisions with and injury to manatees. The permittee shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing manatees which are protected under the Marine Mammal Protection Act, the Endangered Species Act, and the Florida Manatee Sanctuary Act.

- All vessels associated with the construction project shall operate at "Idle Speed/No Wake" at all times while in the immediate area and while in water where the draft of the vessel provides less than a four-foot clearance from the bottom. All vessels will follow routes of deep water whenever possible.

- Siltation or turbidity barriers shall be made of material in which manatees cannot become entangled, shall be properly secured, and shall be regularly monitored to avoid manatee entanglement or entrapment. Barriers must not impede manatee movement.

- All on-site project personnel are responsible for observing water-related activities for the presence of manatee(s). All in-water operations, including vessels, must be shut down if a manatee(s) comes within 50 feet of the operation. Activities will not resume until the manatee(s) has moved beyond the 50-foot radius of the project operation, or until 30 minutes elapses if the manatee(s) has not reappeared within 50 feet of the operation. Animals must not be herded away or harassed into leaving.

- Any collision with or injury to a manatee shall be reported immediately to the FWC Hotline at 1-888-404-FWCC. Collision and/or injury should also be reported to the U.S. Fish and Wildlife Service in Jacksonville (1-904-731-3336) for north Florida or Vero Beach (1-772-562-3909) for south Florida.

- Temporary signs concerning manatees shall be posted prior to and during all in-water project activities. All signs are to be removed by the permittee upon completion of the project. Awareness signs that have already been approved for this use by the Florida Fish and Wildlife Conservation Commission (FWC) must be used (see MyFWC.com). One sign which reads *Caution: Boaters* must be posted. A second sign measuring at least 81/2" by 11" explaining the requirements for "Idle Speed/No Wake" and the shutdown of in-water operations must be posted in a location prominently visible to all personnel engaged in water-related activities.

4.36.3. SMALLTOOTH SAWFISH

St. Lucie County will comply with the following NMFS construction conditions to protect smalltooth sawfish.

- The permitee shall instruct all personnel associated with the project of the potential presence of the species and need to avoid collisions with smalltooth sawfish. All construction personnel are responsible for observing water-related activities for the presence of smalltooth sawfish.

- The contractor shall advise all personnel that there are civil and criminal penalties for harming, harassing, or killing smalltooth sawfish, which are protected under the Endangered Species Act of 1973.

- Siltation barriers shall be made of material in which a smalltooth sawfish cannot become entangled, be properly secured, and be regularly monitored to avoid entrapment. Barriers may not block smalltooth sawfish or exit from designated critical habitat without prior agreement from the National Marine Fisheries Service's Protected Resources Division, St. Petersburg, Florida.

- All vessels associated with the construction project shall operate at "no wake/idle" speeds as all times while in the construction area and while in water depths where the draft of the vessels provides less than a four-foot clearance from the bottom. All vessels will preferentially follow deep-water routes (e.g., marked channels) whenever possible.

- If a smalltooth sawfish is seen within 100 yards of the active daily construction/dredging operation or vessel movement, all appropriate precautions shall be implemented to ensure its protection. These precautions shall include cessation of operation of any moving equipment closer than 50 feet of a smalltooth sawfish. Operation of any mechanical construction equipment shall cease immediately if a smalltooth sawfish is seen within a 50-foot radius of the equipment. Activities may not resume until the protected species has departed the project area on its own volition.

- Any collision with and/or injury to a smalltooth sawfish shall be reported immediately to the National Marine Fisheries Service Protected Resources Division (727-824-5312) and the local authorized sea turtle stranding/rescue organization.

4.36.4. TURBIDITY

Implementation of the following measures would help avoid/minimize turbidity related impacts:

- The Contractor shall monitor water quality (turbidity) twice daily at the dredging and beach placement sites, as required by project permits.

- If turbidity values at the dredging site exceed permitted values, the Contractor shall suspend all dredging activities. Dredging shall not continue until water quality meets state standards.

4.37. COMPLIANCE WITH ENVIRONMENTAL REQUIREMENTS

4.37.1. NATIONAL ENVIRONMENTAL POLICY ACT OF 1969

The National Environmental Policy Act (NEPA) establishes national environmental policy and goals for the protection, maintenance, and enhancement of the environment and it provides a process for implementing these goals within the federal agencies. The purpose of NEPA is to create a policy that will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment, and stimulate the health and welfare of man; and to enrich the understanding of the ecological systems and natural resources important to the Nation. The Act also establishes the Council on Environmental Quality (CEQ).

The Act ensures that for any major Federal actions significantly affecting the quality of the human environment, that a detailed assessment of the environmental impact of the Applicant's preferred plan, any adverse environmental effects which cannot be avoided should the proposal be implemented, alternatives to the Applicant's preferred plan, the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and any irreversible and irretrievable commitments of resources which would be involved in the Applicant's preferred plan should it be implemented.

Since the St. Lucie County South County Dune and Beach Restoration Project required a permit from a Federal Agency, the USACE, it is classified as a Federal action. This EIS provides the mechanisms for the project to comply with NEPA.

4.37.2. ENDANGERED SPECIES ACT OF 1973

Section 7 of the ESA states that any project authorized, funded, or conducted by any Federal agency should not "… jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined … to be critical." The USACE is required to "informally" consult with the USFWS, the National Oceanic and Atmospheric Administration (NOAA), and NMFS to determine whether any federally-listed or proposed endangered or threatened species or their designated critical habitats occur in the project area. The USACE determined that the project "may affect" these listed species or habitats. The USACE prepared a Biological Assessment (BA) (**Appendix G**) to identify the nature and extent of impacts and recommend measures that would avoid or reduce potential impacts on the species. Therefore, the USACE will initiate "formal" consultation under Section 7 of the ESA with NMFS and USFWS. NMFS has provided the 1997 Regional Biological Opinion on Hopper Dredging along the South Atlantic Coast (1997 SADRBO) for hopper dredging related to swimming sea turtles, which stated hopper dredging activities will not jeopardize the continued existence of swimming sea turtles and that no further consultation is required for hopper dredging activities. In addition, the 1997 SADRBO indicated that the effects of hopper dredging on humpback whales and North Atlantic right whales, may affect, but is not likely to adversely affect, these species and no further consultation related to hopper dredging activities is required. If their opinion is that the Project is not likely to jeopardize any listed species or result in the destruction or adverse modification of critical habitat, they may also issue an incidental take statement as an exception to the takings prohibitions in Section 9 of the ESA.

4.37.3. FISH AND WILDLIFE COORDINATION ACT OF 1958

The Fish and Wildlife Coordination Act (FWCA) provides the basic authority for the Fish and Wildlife Service's involvement in evaluating impacts to fish and wildlife from proposed water resource development projects. The Act requires that fish and wildlife resources receive equal consideration to other project features and also requires

Federal agencies that construct, license or permit water resource development projects to first consult with the USFWS and the National Marine Fisheries Service as applicable as well as State fish and wildlife agency regarding the impacts on fish and wildlife resources and measures to mitigate these impacts.

4.37.4. NATIONAL HISTORIC PRESERVATION ACT OF 1966

Archival research, field investigations, and consultation with the Florida State Historic Preservation Officer (SHPO) were completed in accordance with the National Historic Preservation Act, as amended; the Archeological and Historic Preservation Act, as amended; and Executive Order 11593. Refer to **Section 4.16** for the results of SHPO consultation. The project will not affect historic properties included in or eligible for inclusion in the National Register of Historic Places. The project complies with each of these Federal laws.

4.37.5. CLEAN WATER ACT OF 1972

The objective of the Clean Water Act (CWA) is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. The CWA establishes the basic structure for regulating discharges of pollutants into the waters of the U.S. and regulating quality standards for surface waters. The act aimed to attain a level of water quality that "provides for the protection and propagation of fish, shellfish, and wildlife, and provides for recreation in and on the water" by 1983 and to eliminate the discharge of pollutants into navigable waters by 1985.

Under the CWA, EPA has implemented pollution control programs such as setting wastewater standards for industry and also set water quality standards for all contaminants in surface waters. The CWA made it unlawful to discharge any pollutant from a point source into navigable waters, unless a permit was obtained. In order to comply with the CWA, under Section 404, a Corps permit is required for the discharge of dredged or fill material into waters of the U.S.

4.37.6. CLEAN AIR ACT OF 1972

The proposed project will not require air quality permits. This project will include coordination with the EPA and will comply with Section 309 of this act.

4.37.7. COASTAL ZONE MANAGEMENT ACT OF 1972

The Coastal Zone Management Program federal consistency review process is described in 15 C.F.R. 930: Federal Consistency with Approved Coastal Management Programs Regulation, as amended. Federal consistency is the Coastal Zone Management Act provision requiring that - federal agency activities that have reasonably foreseeable effects on any land or water use or natural resource of the coastal zone be consistent to the maximum extent practicable with the enforceable policies of a coastal state's federally approved coastal management program. The State of Florida's Coastal Management Program (FCMP) was accepted by the National Oceanic and Atmospheric Administration in 1981 and is based on a network of multiple state agencies implementing 24 state statutes that protect and enhance the state's natural, cultural, and economic coastal resources (www.dep.state.fl.us/cmp/federal/14 statutes.htm). The goal of the program is to coordinate local, state, and federal agency activities using existing laws to protect Florida's "coast". The Florida Department of Environmental Protection is responsible for directing and coordinating the implementation of the state-wide Coastal Management Program.

Florida's coastal zone stretches beyond its coastal counties to include the entire state's land area and territorial seas minus the lands the federal government owns, leases, holds in trust, or whose use is otherwise by law subject to the sole discretion of the Federal government, its officers, or agents, as well as lands held by the Seminole and Miccosukee Indian Tribes. Federal consistency review is required for any project that is within, or is expected to affect the resources, land or water uses of the Florida coastal zone and requires a Federal license or permit, is federally funded, or is a direct activity of a Federal agency. As the St. Lucie County Shoreline Protection Project requires a Federal permit, the Project meets the criteria for Federal consistency review.

4.37.8. FARMLAND PROTECTION ACT OF 1981

The proposed project will not impact prime or unique farmland. The act does not apply.

4.37.9. WILD AND SCENIC RIVER ACT OF 1968

The proposed project will not affect any designated Wild and Scenic River reaches. The act does not apply.

4.37.10. MARINE MAMMAL PROTECTION ACT OF 1972

Under the authority of the MMPA (Marine Mammal Protection Act of 1972; 16 U.S.C. §§ 1361 et seq.), the Secretary of Commerce is responsible for the protection of all marine mammals except walruses, polar bears, sea otters, manatees, and dugongs, which are the responsibility of the Secretary of the Interior. These responsibilities have been delegated to NMFS and the USFWS, respectively.

The MMPA prohibits the "take" of marine mammals, with certain exceptions, in waters under U.S. jurisdiction and by U.S. citizens on the high seas. Under Section 3 of the MMPA, "take" is defined as "harass, hunt, capture, kill, or attempt to harass, hunt, capture or kill any marine mammal". In the 1994 amendments to the MMPA, two levels of "harassment" were defined. "Harassment" is defined as any act of pursuit, torment, or annoyance that has the potential to injure a marine mammal or marine mammal stock in the wild (Level A); or any act that has the potential to disturb a marine mammal or marine mammal stock in the wild by disrupting behavioral patterns, including, migration, breathing, nursing, breeding, feeding, or sheltering (Level B). In cases where U.S. citizens are engaged in activities, other than fishing, that result in "unavoidable" incidental take of marine mammals, the Secretary of Commerce can issue a "small take authorization." The authorization can be issued after notice and opportunity for public comment if the Secretary of Commerce finds negligible impacts. The MMPA requires consultations with NMFS if impacts on marine mammals are unavoidable. The scoping letters received from NMFS indicates that their opinion is that there will be no impact on marine mammals for project implementation.

4.37.11. ESTUARY PROTECTION ACT OF 1968

The proposed project will not affect any designated estuaries. The act does not apply.

4.37.12. FEDERAL WATER PROJECT RECREATION ACT

Funding for this project includes no federal monies. Therefore, the Federal Water Project Recreation Act does not apply.

4.37.13. FISHERY CONSERVATION AND MANAGEMENT ACT OF 1976

The project is being coordinated with NMFS and will be in compliance with the Fishery Conservation and Management Act

4.37.14. SUBMERGED LANDS ACT OF 1953

The Submerged Lands Act (SLA) granted title to the natural resources located within 3 miles of the adjacent State's coastline (3 marine leagues for Texas and the Gulf coast of Florida). For purposes of the SLA, the term "natural resources" includes oil, gas, and all other minerals, including sand resources. This Act provides for the jurisdiction of the borrow area sand resources by the State of Florida.

4.37.15. COASTAL BARRIER RESOURCES ACT AND COASTAL BARRIER IMPROVEMENT ACT OF 1990

The Applicant's preferred plan would protect adjacent coastal barrier resources by restoring valuable beach and dune habitat. Placement of approximately 610,000 cy of sand within the project area would contribute to the sand-sharing system and provide feeder benefits to adjacent shorelines. This project will comply with this act.

4.37.16. RIVERS AND HARBORS ACT OF 1899

The proposed project will not obstruct navigable waters of the United States. This project will be subject to public notice, public hearing, and other evaluations normally conducted for activities subject to the act. This project will comply with this act.

4.37.17. ANADROMOUS FISH CONSERVATION ACT

This project will not affect anadromous fish and will include coordination with NMFS. This project will comply with this act.

4.37.18. MIGRATORY BIRD TREATY ACT AND MIGRATORY BIRD CONSERVATION ACT

The Migratory Bird Treaty Act of 1918 makes it unlawful to pursue, hunt, take, capture, kill or sell birds listed therein ("migratory birds"). The statute does not discriminate between live or dead birds and also grants full protection to any bird parts including feathers, eggs and nests. Over 800 species are currently on the list. The U.S. has entered into Treaties with Great Britain, Canada, Japan, Mexico, and Russia to protect migratory birds. The Treaties not only stipulate protections for the birds themselves, but also for habitats and environs necessary for the birds' survival. Impacts to migratory birds will be mitigated by implementation of conservation measures required by the Migratory Bird Treaty Act and the Migratory Bird Conservation Act. The project will comply with both acts.

4.37.19. MARINE PROTECTION, RESEARCH, AND SANCTUARIES ACT

The Marine Protection, Research, and Sanctuaries Act does not apply to this project.

4.37.20. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT

The Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. § 1801-1882) established regional FMCs and mandated that FMPs be developed to responsibly manage exploited fish and invertebrate species in Federal waters of the U.S. When Congress reauthorized this act in 1996 as the Sustainable Fisheries Act, several reforms and changes were made. One change was to charge the NMFS with designating and conserving EFH for species managed under existing FMPs. Charging the NMFS with this responsibility was intended to minimize, to the extent practicable, any adverse effects on habitat caused by fishing or non-fishing activities and identify other actions that encourage the conservation and enhancement of such habitat. NMFS recommends consolidated EFH consultations with interagency coordination procedures required by other statutes such as NEPA or the ESA (50 CFR 600.920(e)(1)) to reduce duplication and improve efficiency. The mandatory content of an EFH Assessment is detailed in 50 CFR 600.920(e)(3). The EFH Evaluation is presented in **Appendix H**.

4.37.21. E.O. 11990, PROTECTION OF WETLANDS

This project will not affect wetlands as defined by the Order. The project does not apply to the goals addressed in this Executive Order.

4.37.22. E.O. 11988, FLOODPLAIN MANAGEMENT

No activities associated with the proposed project will take place within a riparian, lacustrine, or estuarine floodplain; therefore, this project is in compliance with the goals of Executive Order 11988.

4.37.23. E.O. 12898, ENVIRONMENTAL JUSTICE

Executive Order 12898 provides that to the greatest extent practicable and permitted by law, Federal agencies shall ensure that there is not disproportionately high and adverse human health or environmental effects from its programs, policies, and activities on minority populations and low-income populations in the U.S. There are no minority or low income populations within the project area; however, if an upland source for backfill is used there may be the potential for the presence of minority or low income populations nearby. If an upland borrow source is used, it would be obtained from an existing mine, and therefore there would be no additional impact if minority or low income populations are present.

4.37.24. E.O. 13089, CORAL REEF PROTECTION

The Coral Reef Protection Executive Order (E.O). defines U.S. coral reef ecosystems as “those species, habitats, and other natural resources associated with coral.” Presence of corals and/or octocorals in the project area is extremely rare; however, hardbottom areas in deeper water further offshore support octocorals and several genera of scleractinian corals including *Oculina*, *Siderastrea*, and *Phylangia* (CSA International, Inc., 2010a). No impacts to the deep water corals offshore of the project area are expected.

4.37.25. E.O. 13112, INVASIVE SPECIES

The proposed project is not expected to introduce invasive species.

5. LIST OF PREPARERS AND REVIEWERS

5.1. PREPARERS

This document was prepared by Taylor Engineering, Inc. and CSA International, Inc. (CSA). **Table 5.1-1** lists the individuals that contributed to the technical content in this document.

Table 5.1-1. List of Preparers

Preparer	Affiliation	Education	Years of Experience
David. L. Stites	Taylor Engineering, Inc.	Ph.D. Aquatic Ecology M.S. Applied Biology/Aquatic Ecology B.S Biology	25
Christopher B. Ellis	Taylor Engineering, Inc.	B.S. Environmental Science	11
M. Alexandra Carvalho	Taylor Engineering, Inc.	Ph.D. Oceanography B.S. Marine Biology and Fisheries	12
Steven J. Schropp	Taylor Engineering, Inc.	Ph.D. Biological Oceanography M.S. Biology B.S. Marine Biology	25
David B. Snyder	CSA International, Inc.	M.S. Marine Biology/Ichthyology B.S. Zoology	32
Erin C. Hodel	CSA International, Inc.	M.S. Marine Biology B.S. Biology	6
Kimberley R. Olsen	CSA International, Inc.	B.S. Oceanographic Technology	27
Melanie L. Cahill	CSA International, Inc.	B.S. Marine Science	5
Neal W. Phillips	CSA International, Inc.	Ph.D. Ecology M.S. Marine Studies B.A. Biological Sciences	34
Stephen T. Viada	CSA International, Inc.	M.S. Biological Oceanography B.S. Zoology	32
Tony R. Martin	CSA International, Inc.	M.S. Biology B.S. Marine Biology	19

5.2. REVIEWERS

Table 5.2-1 lists the individuals that reviewed the content of this document.

Table 5.2-1. List of Reviewers

Reviewer	Affiliation
Paul DeMarco	U.S. Army Corps of Engineers
Garret Lips	U.S. Army Corps of Engineers
Leah Oberlin	U.S. Army Corps of Engineers
Geoffrey Wikel	Bureau of Ocean Energy Management, Regulation, and Enforcement
Michael Krecic, P.E.	Taylor Engineering, Inc.
Frank Linn	Taylor Engineering, Inc.
Rajesh Srinivas, Ph.D., P.E.	Taylor Engineering, Inc.
Steven J. Schropp, Ph.D.	Taylor Engineering, Inc.

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